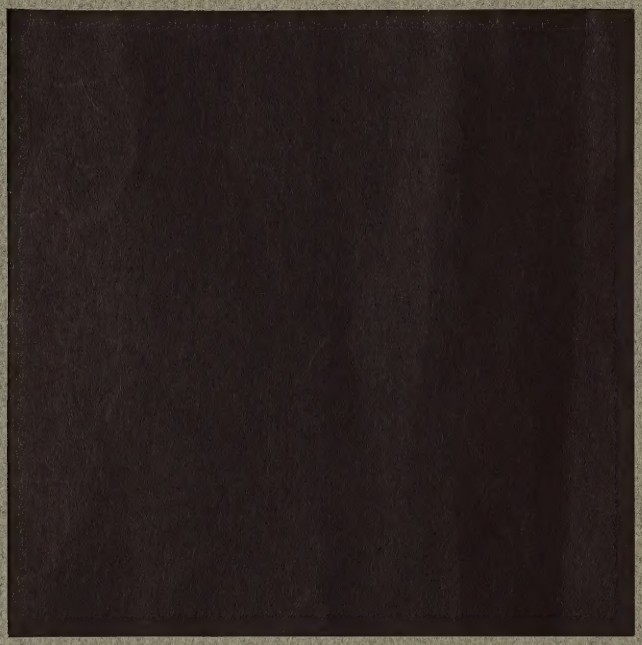
TRIMPACK™

SPECIFICATION, INSTALLATION

AND REFERENCE MANUAL

INCLUDES HAVE-QUICK OPTION

Part Number 13498
Revision D



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Trimble Navigation Limited
585 North Mary Avenue
Sunnyvale, CA 94086

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TRIMPACK™ WARRANTY

As an expression of confidence in our products to continue meeting the high standards of reliability and performance that our customers have come to expect, Trimble Navigation products carry the following warranty:

Warranty Statement

Trimble Navigation Limited products are warranted against defects in materials and workmanship. The warranty period for each product will be provided on request at the time of sale and is specified in documentation supplied with the product. During the warranty period, Trimble Navigation Limited will, at its option, either repair or replace products which prove to be defective.

Buyer shall prepay shipping charges for products returned to Trimble Navigation Limited for warranty service and Trimble Navigation Limited shall pay for return of the products to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Trimble Navigation Limited from outside the United States.

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The foregoing warranty shall not apply to defects resulting from:

1. Improper or inadequate maintenance by Buyer;
2. Buyer-supplied software or interfacing;
3. Unauthorized modification or misuse;
4. Operation outside of the environmental specifications for the product; or
5. Improper installation, where applicable.

No other warranty is expressed or implied. Trimble Navigation Limited specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are Buyer's sole and exclusive remedies. Trimble Navigation Limited shall not be liable for any direct, indirect, special incidental or consequential damages, whether based on contract, tort, or any other legal theory.

Warranty Repair

For warranty repair, please call (800) TRIMBLE (outside California) or (408) 737-6940 (inside California) to request an RMA number from the Service Representative. Ship the equipment (with RMA number noted) to Government Systems, Trimble Navigation Ltd., 570 Maude Court, Sunnyvale, CA 94086.

TRIMPACK is a trademark of Trimble Navigation Limited

WARNING

The **WARNING** sign denotes a personal hazard. It calls attention to an operating procedure, practice or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

The case of the TRIMPACK conducts electricity, even though it is made of plastic. When connecting the unit to an external power source, be careful to avoid electrical shock just as if the case were metal.

The battery pack at the rear of the TRIMPACK may contain lithium batteries. Lithium batteries contain flammable materials and require special handling. To prevent rupture or leakage of battery fluid, the following safety precautions MUST be observed:

- **Do not:** puncture batteries.
  short circuit batteries.
  place batteries into a fire.
  recharge lithium batteries.
  heat the batteries.
  reverse polarity when installing batteries.
  dispose of discharged batteries except as prescribed in Federal and State regulations.

- **Do not** leave loaded battery pack in the direct sunlight for extended periods.

- **Do not** leave loaded battery pack inside closed vehicle exposed to the sun.

CAUTION

The **CAUTION** sign denotes an equipment hazard. It calls attention to an operating procedure, practice or the like, which, if not correctly performed or adhered to, could result in damage, or incorrect operation of the equipment. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

The TRIMPACK is designed for rugged use in difficult field environments. It will operate continuously in air temperatures from -30° to +65°C and in environments with up to 100% humidity. However, you should take reasonable care of the TRIMPACK as with any other piece of high-precision equipment.

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DOCUMENT IMPROVEMENT FORM

Reporting Errors and Recommending Improvements

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail TNL form 88-PS0411, located in the back of this manual, or your letter to

Trimble Navigation Limited
585 North Mary Avenue
Sunnyvale, CA 94086
ATTN: Pat Sugg

A reply will be furnished to you explaining our action.

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1.0 DOCUMENT SCOPE

The TRIMPACK is a Global Positioning System (GPS) self-contained navigation system designed for use in low to moderate dynamic applications where low power, light weight, and small size are required. TRIMPACK has been designed to meet military environmental specifications to the greatest extent achievable while maintaining a commercially competitive product. The result is a highly reliable, rugged positioning and navigation system at an affordable price.

This document establishes the functional and physical characteristics of the TRIMPACK system, the operational specifications to which it was designed, and the standards under which it is manufactured. Maintenance and repair, although planned to be at factory or depot level only (see paragraph 6.5 of this document), is addressed to allow the knowledgeable user to diagnose TRIMPACK problems. For the user who will integrate TRIMPACK into a vehicle or system, this document provides detailed mechanical, electrical and digital interface definitions, and system operational procedures.

This document applies specifically to the newest generation TRIMPACK receivers with part numbers 16768-XX as shown in the table below, but can also be used with the previous generation TRIMPACK, P/N 12545-00, with attention to several differences. The part number label can be found on the back panel of the receiver where the battery pack is mounted.

MANUAL APPLICABILITY

Receiver P/N	Description	Comment
16768-00	TRIMPACK (Red Display)	Baseline for Manual
16768-10	TRIMPACK with HAVE QUICK/ Pulse-Per-Second Output	Described in Appendix D
16768-20	TRIMPACK (Green Display)	Baseline for Manual
16768-30	TRIMPACK with 1089 waypoints	Described in Appendix E
12545-00	Previous Generation TRIMPACK	Differences Highlighted Below

The first version is the basic receiver while the second is adapted with an additional timing output capability for HAVE QUICK or Pulse-Per-Second signals. The timing output version of the receiver and a version with expanded (1089) waypoints are described in Appendices at the end of the manual.

The manual is largely applicable to the previous generation TRIMPACK receiver, P/N 12545-00. The only significant changes are modifications to the user interface relative to waypoint handling. These differences are summarized below.

RECEIVER FEATURE COMPARISON

P/N 12545-XX

- No Label Search
- Specify Saved Waypoint
- Dist, Calc for Waypoints Only
- Two Backlight Levels

P/N 16768-XX

- Waypoint Label Alphanumeric Search
- Waypoint saved to Next Available Empty Waypoint
- Dist, Calc for FIX & Waypoints
- Four Backlight Levels, Including Off

2.0 APPLICABLE DOCUMENTS

2.1 Issue of Documents

The issue of each document which existed on 1 July 1988 is the issue to be used.

2.2 Applicability

Each document is applied as directed in this specification. This specification has precedence if a conflict exists. The application of the following military specifications and standards is made on a selective basis. All requirements are tailored to agree with the design philosophy of TRIMPACK.

2.3 Documents

The reader is referred to the following documents for additional related information.

SPECIFICATIONS

Federal

None applicable.

Military

MIL-E-4158E	Ground: General Requirements for Electronic Equipment
MIL-E-5400T	General Specification for Aerospace Electronic Equipment
MIL-P-11268	Parts, Materials, and Processes Used in Electronic Equipment
MIL-E-16400G	General Specification for Naval Ship and Shore Electronic, Interior Communications and Navigation Equipment
MIL-T-23103A	General Requirement for Thermal Performance Evaluation of Airborne Electronic Equipment and Systems
MIL-B-49430/11C(ER)	Battery, Non-rechargeable, Lithium Sulfur Dioxide BA-5800/U

Other Government

SS-GPS-300B	System Specification for the Navstar Global Positioning System
ICD-GPS-200	NAVSTAR GPS Space Segment/Navigation User Interfaces

STANDARDS

Military

MIL-STD-108	Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461B	Electromagnetic Emission Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Measurement of Electromagnetic Interference Characteristics
MIL-STD-704D	Aircraft Electric Power Characteristics
MIL-STD-781C	Reliability Design Qualification and Production Acceptance Tests: Exponential Distribution
MIL-STD-810D	Environmental Test Methods

Others

DMA TR-002	Department of Defense World Geodetic System 1984(U)
DA TM 5-241-1	Grids and Grid References (updated per DMATC packet DATMX52411C1)
MIL-HDBK-217E	Reliability Predictions for Electronic Equipment
TTP-92201	TRIMPACK Environmental Test Plan and Procedure
TTR-92301	TRIMPACK Environmental Test Report
EMTR-92302	TRIMPACK EMI Test Report

3.0 SYSTEM DEFINITION

3.1 General Functional Description

The TRIMPACK is a GPS navigation receiver which uses C/A code, L1 frequency. It is specifically intended to be a handheld, light weight, battery-powered personal navigation system which delivers 3-dimensional position and velocity, time, and calculates waypoint, steering and navigational data for the user.

The TRIMPACK includes a built-in antenna, a receiver section, a digital/computer section, a display, switches for data input, and a battery pack for the self-contained power supply. Connectors on the TRIMPACK allow the use of an external antenna, external power input, and a data communications port.

TRIMPACK provides worldwide, day/night, all weather position and velocity data. The TRIMPACK utilizes three sequencing signal processing channels to compute three-dimensional position and velocity and to manage and maintain the satellite tracking process. The TRIMPACK receives GPS satellite signals using a fixed pattern antenna. The TRIMPACK displays time-tagged position and velocity at intervals of approximately one second. Output information is communicated digitally via an RS-422 data channel at a data rate of 9600 baud.

3.2 System Component Description

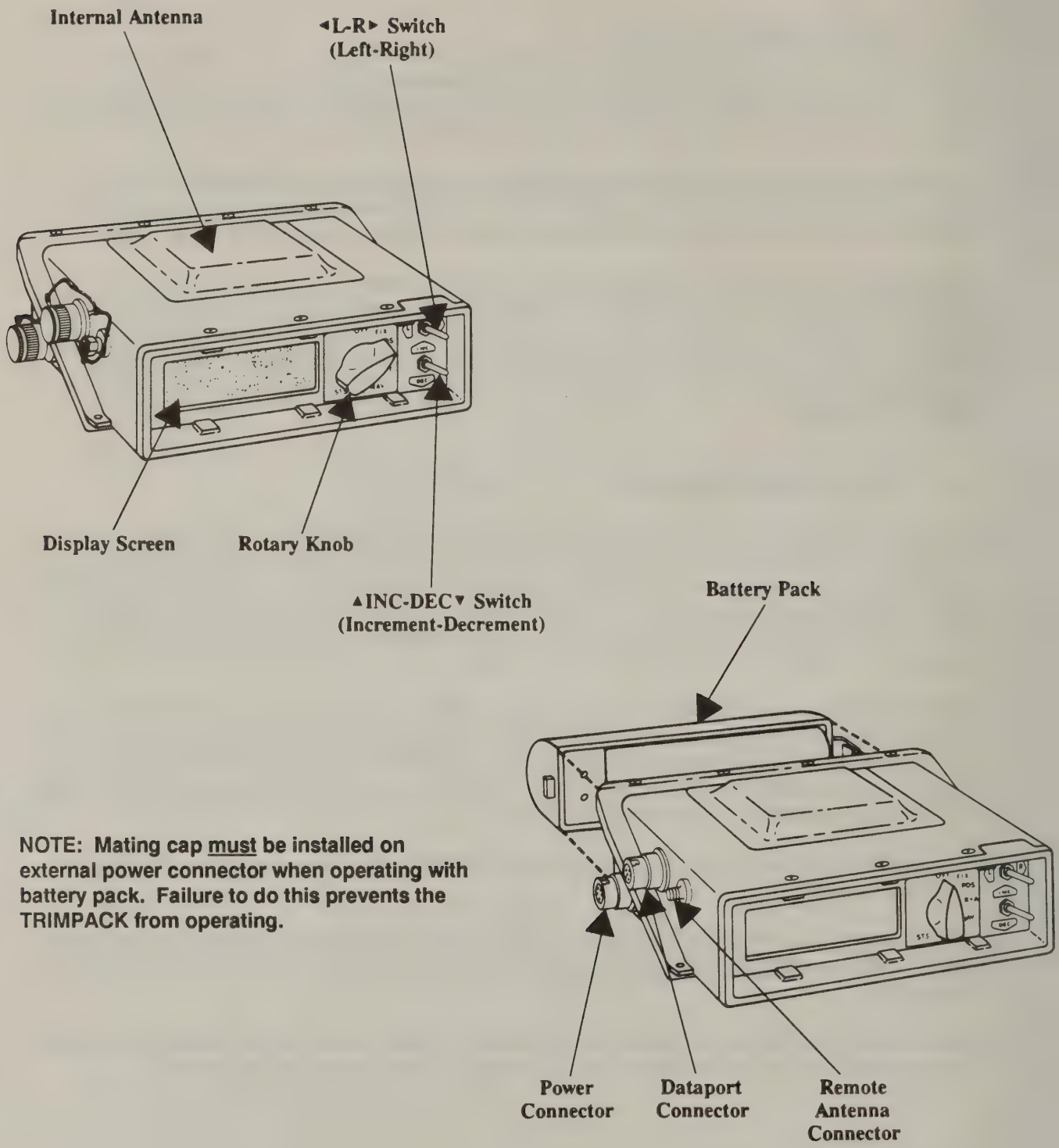
The TRIMPACK consists of the necessary hardware and software required for satellite signal processing and solution computation. A 5-pin connector accommodates external system power and a 6-pin connector provides the RS-422 digital communication interface. The external antenna cable interface is provided through an SMA type coaxial connector. The connectors are located on the left side panel. The TRIMPACK housing is environmentally sealed. A drawing of the TRIMPACK and its major features is shown in Figure 3-1.

The TRIMPACK has a four line, 20 column Liquid Crystal Display (LCD) with characters displayed on a five by seven dot matrix. Integrally-mounted Light Emitting Diodes (LED) provide a backlighting source which is software controlled to one of four brightness levels. The view angle is optimized for an observer located directly in front of the display and is not adjustable. This display uses a wide temperature liquid for operation over the temperature range -30 to +65 degrees C.

An 8-position rotary switch is used to turn the TRIMPACK ON and OFF, as well as access the various operational modes.

A center-biased 3-position switch, labeled as L and R, is used to select among user-alterable fields of the display. This switch incorporates an auto-repeat function which is activated when the switch is held in either position.

A center-biased 3-position switch, labeled as INC and DEC, is used to move through multiple screens and to change data values of selected data fields. This switch also has an auto-repeat function.



NOTE: Mating cap must be installed on external power connector when operating with battery pack. Failure to do this prevents the TRIMPACK from operating.

Figure 3-1. TRIMPACK

A board level block diagram for the TRIMPACK is shown in Figure 3-2. The three connectors are shown as the only external interfaces.

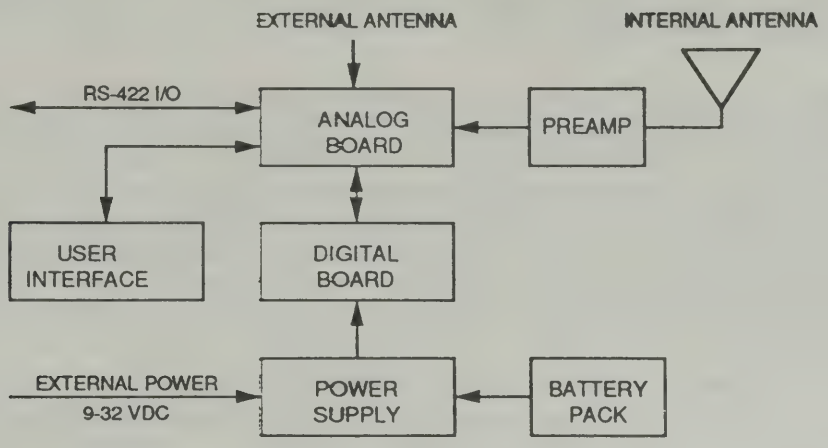


Figure 3-2. Board Level Block Diagram

The Power Supply Board regulates and converts the voltage from the 9 to 32 VDC input to the 5 VDC required to power the electronic components. When operating on batteries, the same power supply operates with input voltages as low as 5.5 Volts. Several battery packs, all compatible with the TRIMPACK, are available. Each of these battery packs accepts different types and numbers of cells and are either rechargeable or non-rechargeable, depending on the battery chemistry. Section 6.1 describes the various battery pack configurations and the projected operating life for each.

The TRIMPACK receives the satellite signals through the internal antenna on the top panel or through an optional external antenna. The complete process, from signal processing to digital output control, is performed by the components on the analog and digital boards. Figure 3-3 provides a block diagram of the major functional components and assemblies of the TRIMPACK.

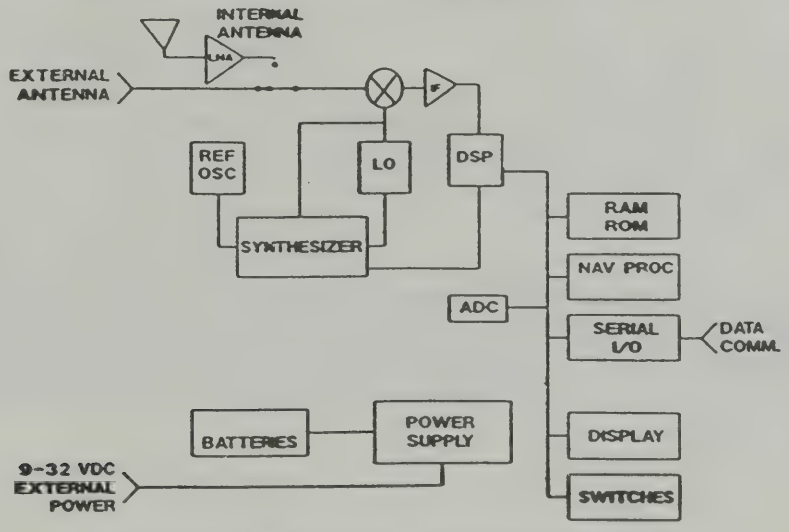


Figure 3-3. TRIMPACK Functional Block Diagram

The Reference Oscillator is a high stability crystal oscillator which contains circuitry to correct the frequency over the entire operating temperature range of the TRIMPACK. The synthesizer module is a single in-line pack (SIP) containing a custom IC and additional circuitry to form a synthesizer generating the clock signals used in the TRIMPACK.

The Digital Signal Processor (DSP) custom IC contains hardware for tracking the GPS signals and extracting carrier and code information as well as the 50 bits per second data. The 68000 microprocessor controls the operation of the tracking hardware in the custom IC. In addition, it can control each tracking channel to sequence on as many as 8 separate satellites for collecting measurements and data. The measurements and data are used to compute the GPS-based position and velocity solution. The microprocessor also controls the selection of which satellites will be tracked and manages the orbital information data and almanac for all of the satellites, as well as managing user interface and providing waypoint storage and navigation facilities.

The microprocessor gets initial time information from the real time clock. The battery powered, real time clock is able to provide an approximate initial time to the navigation processor whenever the TRIMPACK is turned on. The A-to-D converter allows the navigation processor to monitor the status of the synthesizer module, IF module, antenna power supply feeds, internal temperature, and display temperature. The navigation processor communicates via a dual universal asynchronous receiver transmitter (DUART), a bi-directional configurable data port. The port is electrically RS-422 compatible.

TRIMPACK is a self-contained GPS receiver and has an integrated antenna/preamplifier. The internal antenna has the same characteristics as the external antenna except the 42 to 50 dB gain is reduced to 32 to 38 dB (see next paragraph). When the remote antenna is installed, the internal antenna/preamplifier is deactivated.

External Antenna/Preamplifier (P/N 12038-00). The external antenna/preamplifier consists of a flat, microstrip, antenna element and a preamplifier circuit within a single unit. The functional characteristics of these components are listed below in Tables 3-1 and 3-2.

Table 3-1. Antenna Specifications

Frequency:	1565 - 1585 MHz
Polarization:	Right-hand Circular
Gain:	5 dBi (max) 0 deg
	0 dBi (min) 0 - 75 deg
	-2 dBi 75 - 85 deg
Axial Ratio:	3 dB @ 85 deg
Ellipticity:	3 dB (max)

Table 3-2. Preamplifier Specifications

Frequency:	1565 - 1585 MHz
Signal Gain:	42 - 50 dB
Output VSWR:	2.0:1 (max)
Power Rqmt:	80 mA DC, 3.5-4.5 VDC

External Antenna Cable (P/N 12765-00). The external RF interface is through a single coaxial cable. Direct current is carried up to the preamplifier on the center conductor of the coaxial cable and GPS signals are carried from the antenna to the TRIMPACK. Regardless of the length of this cable, the signal attenuation cannot exceed 10 dB at 1575 MHz, the maximum VSWR is 2.0:1, and the round trip DC resistance must not exceed 1 ohm. The coaxial cable must be Belden 83242 low loss, high temperature, coaxial cable or equivalent.

3.3 Physical Characteristics

Weight. The weight of a TRIMPACK is 1.5 kg (3.3 pounds) in a single battery configuration and 1.9 kg (4.2 pounds) in a 2 battery configuration. Weight depends on the battery configuration and the battery type by manufacturer.

Volume. The volume displacement is 1491 cc (91 cu. in.) for the TRIMPACK and 185 cc (11.3 cu. in.) for the external antenna. This is based on single battery configuration using BA-6800.

Dimensions. The dimensions for the TRIMPACK are approximately 165mm x 178mm x 49mm (6.5" x 7.0" x 2"). The low profile external antenna is 96mm x 102mm x 14mm (3.75" x 4.0" x 0.54").

Connectors. The connectors are of military quality. The GC 283-15 was selected based on current carrying capacity, voltage and safety standards. Connectors are sealed and will prevent water intrusion at 2 meters depth. The finish on the connectors is black oxide over stainless steel.

3.4 Mechanical Interface

The TRIMPACK can be mounted at any attitude as long as the external antenna is used. If the user vibration environment is within the design specification of the TRIMPACK provided in section 6.2, the TRIMPACK may be hard mounted. If not, mounting must provide vibration isolation such that the resulting vibration level is within the specification of the equipment.

External Antenna: The external antenna shall be mounted on a flat surface of the host vehicle, positioned to provide maximum satellite visibility. The antenna may be surface mounted using an optional gasket (P/N 12549) and/or sealant specified by the air frame manufacturer. To obtain the specified performance no groundplane is required; however, a properly designed groundplane may improve the performance. The feedline is connected to the antenna by a sealed SMA connector.

Digital Communication: The digital communication interface is provided on a single, 6-pin General Connector GC-283-15. This connector is a bulkhead circular audio mounting connector. It is watertight to 2 meters if the mating connector is installed. The mate is a General Connector GC-329. A dust cap on a nylon lanyard is provided to protect the contacts.

External Power: The external power interface is provided on a 5-pin General Connector, GC-183-15. This connector is watertight to 2 meters if a mating connector is installed. The mate is a General Connector U-229/U. A shorting cap is provided for this connector and is retained by a nylon lanyard. As a safety feature, this shorting cap must be on when operating on internal batteries. IF IT IS NOT PROPERLY INSTALLED, THE TRIMPACK WILL NOT OPERATE.

Antenna/Preamplifier Cable Interface: The TRIMPACK interface to the antenna/preamplifier coaxial cable is a stainless steel, hermetically sealed, SMA-type connector located on the same side as the power and communications connectors. A dust cap on a nylon lanyard is provided to protect the connector.

3.5 Electrical Interface

System Power: The TRIMPACK is powered by a removable battery pack or externally by a 9 to 32 VDC power supply. For the TRIMPACK to use the internal battery the external power connector cap must be in place. Removal of the cap disables the internal batteries from powering the system.

For host vehicle installations, the receiver is capable of continuous, reliable operation from electrical power meeting MIL-STD-704D. The pin out for the GC-183-15 power connector is shown in Table 3-3.

External power is to be supplied through the external power connector. Voltage applied to the battery contacts in excess of 15 Volts will damage the receiver.

Table 3-3. Pin Assignments of GC-183-15 Power Connector

Pin	Name	Description
A	INTERNAL BATTERY, NEGATIVE	Do not use.
B	EXTERNAL GROUND (V -)	External Ground (V-)
C	INTERNAL GROUND (V -)	Do not use.
D	EXT POWER (V +)	External Power (V+)
E	INTERNAL BATTERY, NEGATIVE	Do not use.

Circuits have been included to protect the TRIMPACK from input of off-nominal power conditions. If the TRIMPACK encounters low voltage conditions, it degrades gracefully and returns to full operation upon the restoration of power. If the TRIMPACK encounters an overvoltage condition, the crowbar in the vehicle power adapter protects the system. Overcurrent protection is provided by fuses in the batteries or a fuse in the battery pack. To prevent charging of the lithium batteries, a mechanical safeguard is provided by a shorting cap which must be on the external power port if the TRIMPACK is to operate on batteries. The circuit powering the external antenna via the SMA connector is current limited and will survive sustained shorting to ground.

For MIL-STD-461B compliance while operating on external power, a Vehicle Power Adapter Assembly is available (Trimble Part Number 13825-00). This adapter has flanges for direct mounting to the vehicle chassis and uses a shielded cable with GCU-229/U connectors on each end to supply filtered power to the TRIMPACK. The vehicle power adapter housing should be tightly bonded to the vehicle chassis for maximum shielding effectiveness. The adapter has a barrier strip for (+) and (-) input connections, and contains a fuseholder for 3AG type fuses (2A, >50V).

The TRIMPACK meets FCC Part 15, Subpart J, Class B conducted emissions without the use of the Vehicle Power Adapter.

3.6 Digital Communication Interface

Digital communication is accomplished via a configurable RS-422 channel. A description of the types of information and the associated formats for communicating with the TRIMPACK on this channel is provided in Appendix A.

Table 3-4. Six-pin Data Connector Pin Assignments

Pin	Name	Direction	Description
A	RXD(-)	Input	Receive Data -
B	TXD(-)	Output	Transmit Data -
C	TXD(+)	Output	Transmit Data +
D	RXD(+)	Input	Receive Data +
E	HQ/PPS	Output	HAVE QUICK/Pulse-Per-Second
F	GND		Signal Ground

Trimble-supplied data cables are available with DB-25 connectors for connection to RS-422 devices, or with circular connectors for TRIMPACK-to-TRIMPACK communications. See Appendix D for timing option pin-outs. Pin E is optionally used for timing output version of the TRIMPACK as described in Appendix D.

3.7 Radio Frequency Interface

TRIMPACK is designed to be functionally compatible with the L1 GPS navigation signals as described in the GPS Specification SS-GPS-300B and ICD-GPS-200. The TRIMPACK will operate with the Navigation Development Satellites (NDSs) as well as the Operational Navigation Satellites (ONSs) or a combination thereof.

The TRIMPACK has burn-out protection which prevents damage from RF fields at strengths of up to 100 Volts/meter.

4.0 FUNCTIONAL CHARACTERISTICS

4.1 Acquisition

The TRIMPACK acquisition and tracking process features the ability to determine position without any position initialization. The receiver tracks up to 8 satellites and automatically selects the best 4 of those satellites for computing position. As the satellites move, the TRIMPACK automatically begins tracking new satellites as others move below the elevation mask (the minimum acceptable elevation for tracking) and continues to select the best 4 satellites for computing position.

The following sections describe the acquisition, tracking, and GPS solutions performance of the TRIMPACK receiver.

Upon powering the system, the sensor begins a search for satellites that are expected to be above the horizon. This calculation is based on the battery-backed almanac of satellite orbits, an estimate of current position (based on the receiver's last calculated fix or manual user input), and the current time from the self-contained, real-time clock. If this information is reasonably accurate (position within 1,000 km, time within 5 to 10 minutes), then rapid acquisition of the available satellites occurs. Once locked, if the elapsed time from the previous fix taken by the unit is more than one hour, current satellite ephemeris must be collected from the data message of each satellite. If the required number of satellites is being tracked and the ephemeris data for each is current, then the user position and velocity solution is performed. (For 3-dimensional positioning 4 satellites are required and 3 satellites are required for 2-dimensional positioning.)

The time required for the TRIMPACK to acquire satellites, and to calculate position and velocity, is dependent upon a number of factors. Primarily, it depends on whether the unit has a representative satellite almanac in battery-backed memory, the time elapsed since the previous operating fix, and the distance the unit has been moved since the last operating fix.

If the TRIMPACK has current almanac and current ephemeris (collected from the GPS satellites being tracked) and has not been moved a great distance (approximately 1,000 km) since its last fix, then, after power-up, the TRIMPACK acquires the satellites and begins performing fixes within 1.5 minutes.

The subsequent paragraphs describe processes that lengthen time to first fix, the circumstances under which they are required, and the approximate time impact.

Almanac: The satellite almanac consists of approximate orbit parameter data to aid the sensor in satellite acquisition. This data is held in battery-backed RAM (random access memory) in the sensor. Initial turn-on after manufacture, back-up battery failure, or usage after a significant constellation change are circumstances that would require collection of a new almanac via the satellite data message. This process requires 30 seconds for each satellite and 12.5 minutes for all 32 satellites. (This is because some 30-second data frames contain 2 satellite almanacs.) However, depending on the order of satellite almanacs in the data message, the almanacs for satellites currently above the horizon may be obtained before cycling through all existing satellites. Therefore, collection of almanac data to allow acquisition requires from 2 to 12.5 minutes.

Note that a complete almanac is not required for the TRIMPACK to do position and velocity fixes.

Ephemeris: The satellite ephemeris provides an accurate estimate of satellite position at any given time. This data, like the almanac, is held in battery-backed RAM and is collected from the satellites on roughly an hourly basis during operation. Should the satellite tracking be interrupted for more than an hour (due to either signal blockage or the TRIMPACK being turned off), the sensor requires the collection of new ephemeris before a solution is made. Collection of this data requires 30 seconds per satellite, or 2 minutes for 4 satellites (the number required for a 3-D solution).

Receiver Initial Reference Position: At power-on, to estimate the proper frequencies and which satellites are above the horizon (an elevation value which the operator optionally may enter into the TRIMPACK to prevent it from tracking satellites which appear below this elevation), the TRIMPACK uses the almanac, time, and an estimate of current position. By default, the sensor uses the last calculated position stored in memory. Alternatively, the user can input a position estimate. If the initial reference position is sufficiently accurate, the satellite doppler frequency shifts are accounted for correctly and acquisition occurs rapidly (in a matter of seconds). However, if the search does not yield acquisition at the expected frequencies, the frequency search is expanded around the expected frequency for each of the satellites that the sensor believes is above the horizon.

The receiver does not require an initial position to acquire satellites and to perform GPS solutions. A completely uninitialized TRIMPACK has the ability to determine its position autonomously. Under certain circumstances, the processor executes a special acquisition algorithm. This is a process whereby the receiver uses the initial position stored in memory only as a starting place for doppler search calculations, but the position is not implicitly trusted. This process is invoked whenever the position stored in memory is not a GPS-calculated position (i.e., was user-entered) or when sufficient time has passed since the last fix such that, based on expected host vehicle velocity, the receiver could have moved more than 150 km.

This process searches the expected satellite doppler shifts based on the initial position estimates. If the expected satellites are not found, then the effective elevation mask is lowered to allow the receiver to search for other PRN codes for satellites supposedly below the mask. (The term "PRN" refers to "pseudo-random noise." Each GPS satellite generates its own distinctive PRN code, which is modulated onto its carrier. The PRN code serves as identification of the satellite, as a timing signal, and as a subcarrier for the navigation data.) This mode does not have a significant impact on the time to first fix if indeed the initial position in memory is a reasonable estimate of true position. If no satellite is acquired after the TRIMPACK has searched for 5 minutes, then other satellites are substituted into the satellite search set. Each satellite is given 5 minutes before another is tried. Eventually all 32 satellites are tried, and the process starts again. After one satellite is acquired, it can provide accurate time, rough position, and updated almanac data if needed. If the position is in extreme error, then the search process could add up to 15 minutes to the time to first fix.

The following table summarizes "Time-to-First-Fix" scenarios:

Table 4-1. Time-to-First Fix Scenarios

Sensor state	Example Scenario	TTFF
Fully Initialized	Brief Power-Off	1.5 min
Needs Ephemeris	Daily Power-ON	2.5 min
Needs Almanac	First Power-On after extreme constellation change	5 to 15 min

Signal Interruption: During TRIMPACK operation, should the signal be interrupted (by antenna blockage or disconnect, etc.), the reacquisition time is dependent on events during the interruption.

When tracking lock has been lost on a satellite for more than 15 seconds, then a frequency search is begun. The TRIMPACK makes use of the information that it has about the user and the satellite to direct the center and width of the search. Every 15 seconds until lock is reacquired, a new center and maximum width is computed, and the search range is expanded in 300 Hz steps towards this maximum width. Code search at a given frequency takes about one second and occurs automatically.

If the TRIMPACK internal clock oscillator error is known, it is compensated for. If not, then the maximum search width is set large enough to allow for oscillator tolerance, aging, and temperature errors.

If ephemeris or almanac data is available for the satellite, then its velocity is incorporated into the center frequency. The reduced accuracy of the almanac data is accounted for in the width. If neither is available, then the doppler at last lock is used for 2 minutes. After that, the maximum doppler at last lock is used for 2 minutes. After that, the maximum doppler expected due to a satellite motion is used.

If the TRIMPACK is doing velocity fixes or velocity aiding is being provided, then doppler due to this motion is used. If not, the dynamics code is used to determine the maximum doppler expected. In addition, if position is not known accurately, the search width is increased appropriately.

The user should realize that obstructions, shading, and satellite transmission interruptions can degrade the signal reception and lengthen acquisition times.

4.2 Position and Velocity Solution

The position and velocity, along with the time tag of the measurement, are digitally output over the RS-422 communication channel in the format described in Appendix A. The position data is 3-dimensional and available in X-Y-Z (ECEF) or latitude-longitude-altitude (LLA) coordinate formats. Velocity data is also 3-dimensional, available in X-Y-Z (ECEF) or East-North-Up coordinate systems. Position and velocity time tags can be output as GPS or UTC time at user specification. The GPS solutions are computed at typically one to two second intervals

4.3 Dynamic Capability

The following specifications are the operational dynamic limits for TRIMPACK operation.

Velocity: The velocity of the user is limited to 300 m/s (~600 knots) for proper TRIMPACK operation.

Acceleration: User acceleration is not to exceed 2 g's or 19.5 m/s/s.

4.4 Navigation Capabilities

4.4.1 Position Display

Position coordinates can be displayed in any of the following formats:

- Latitude/Longitude in degrees, minutes, seconds, and tenths of seconds.
- Latitude/Longitude in degrees, minutes, and thousandths of minutes.
- Universal Transverse Mercator (UTM) with easting and northing in meters.
- Military Grid Reference System (MGRS) with 1 meter resolution.

Altitude information can be displayed in either meters or feet, and is automatically geoid corrected to MSL.

4.4.2 Dynamics Calculations

The TRIMPACK can detect motion along any of three axes (up/down, east/west, and north/south) and can thereby derive the following for use in navigation calculations:

- **Velocity** of the TRIMPACK in both magnitude and direction.

- **Course**. The course is only considered valid for speeds greater than 0.6 meters per second. Displayed results of calculations that make use of this figure will not be updated when the speed is too low.

4.4.3 Waypoints

The TRIMPACK stores 26 waypoints which can be displayed and edited in any of the available coordinate formats. A 12-character label is associated with each waypoint for additional identification of the position. A browsing function is provided to alphabetically search for a waypoint's label.

The present position of the TRIMPACK can be saved into a waypoint, and the label will contain a time stamp to indicate the time of save. A waypoint can be copied to the current position to initialize the acquisition process.

A waypoint can be calculated with reference to a previously entered waypoint, or the TRIMPACK's present position, by entering the range, azimuth, and vertical angle. Also, the range, azimuth and vertical difference between two arbitrary waypoints can be calculated and displayed.

A waypoint's data may be copied to any other waypoint.

4.4.4 Navigation to Waypoints

The TRIMPACK can display the following with respect to a selected destination waypoint:

- Range. Calculated as the Great-Circle, constant altitude distance.

- Slant range. The 3-dimensional distance between current position and a destination waypoint (includes both range and vertical difference).

- Azimuth. Calculated from true north or corrected for local magnetic variation. Displayed in either degrees, mils (1/6400 circle), or radians.

- Relative steering angles. The left or right angular difference between the TRIMPACK's present course and the Great-Circle line to the destination and the associated up or down difference between the TRIMPACK's vertical angle and the direct slope line to the destination.

- Estimated Time-To-Go. Using the TRIMPACK's velocity and the slant range to destination waypoint, the estimated elapsed time until arrival at the destination waypoint is displayed, up to a maximum of 99 hours, 59 minutes, and 59 seconds.

- Cross-track Error. The perpendicular horizontal distance from the present position to the Great-Circle line between the starting waypoint and the destination.

4.5 RF Jamming Resistance and Burnout Protection

The TRIMPACK provides resistance to jamming whose effect results in jamming to signal power ratios of 24 dB or less as measured at the antenna/preamplifier interface when input signal is at -133 dBm (-163 dBW). The TRIMPACK provides burnout protection to prevent damage at RF field strengths up to 100 Volts/meter.

4.6 System Status and Diagnostics

Operational Status. All digital circuitry is self-tested to the greatest extent possible at turn-on. This includes testing the memory systems and processor and monitoring the performance of the channel processors. Should a failure occur in any of these areas, it is reported on the interface. Additionally, there is circuitry provided to monitor the status of the feedline between the external antenna assembly and the TRIMPACK. This circuitry will detect both short and open conditions in the feedline and report them on the interface. The TRIMPACK system also has an error flag that is set when the clock bias rate in the receiver exceeds a predetermined value. The system will continue to operate under these conditions, however, the acquisition time may be degraded when the clock is too far off the nominal frequency.

Self-confidence Test and Operator Failure Diagnoses. At turn-on, the TRIMPACK initiates a built-in test sequence which will determine if the TRIMPACK is operating properly or the failure mode which occurred. These tests meet the following requirements:

- The test sequence detects 90% of all major failures and has not more than a 5% false alarm rate.
- The cause of the detected malfunction is output in code or words to the operator interface.

4.7 GPS Solution Modes

Two-dimensional (2-D) mode is an altitude-hold mode where the TRIMPACK will navigate using the last computed or user-entered altitude. This mode requires acceptable signals from three satellites. The navigation solution uses the pseudo-ranges from the three satellites plus altitude. The system will automatically select the best three available satellites based on the Horizontal Dilution of Precision (HDOP).

In three-dimensional (3-D) mode the TRIMPACK will select the best available four satellites based on Position Dilution of Precision (PDOP) and provide a navigation solution in three dimensions.

The TRIMPACK provides for an automatic transition between the 2-D and 3-D modes. The 3-D mode will be used if four satellites or more are available, choosing the best four satellites based on PDOP. If the four satellites available have a PDOP higher than 8, the TRIMPACK will automatically revert to the best three satellites available and 2-D mode. If there are only three satellites available, the TRIMPACK will operate in 2-D mode if the PDOP is less than 12.

When the TRIMPACK transitions from 3-D to 2-D, it will use the last calculated GPS altitude. It can also be forced to use a user-entered altitude, at any time it is using 3 satellites, by re-entering the altitude.

When the TRIMPACK is stationary, the averaging feature can be enabled. This function provides a more stable time-averaged estimate of the position. This feature can be used for coarse surveying applications.

5.0 USER INTERFACE

5.1 Controls and Indicators

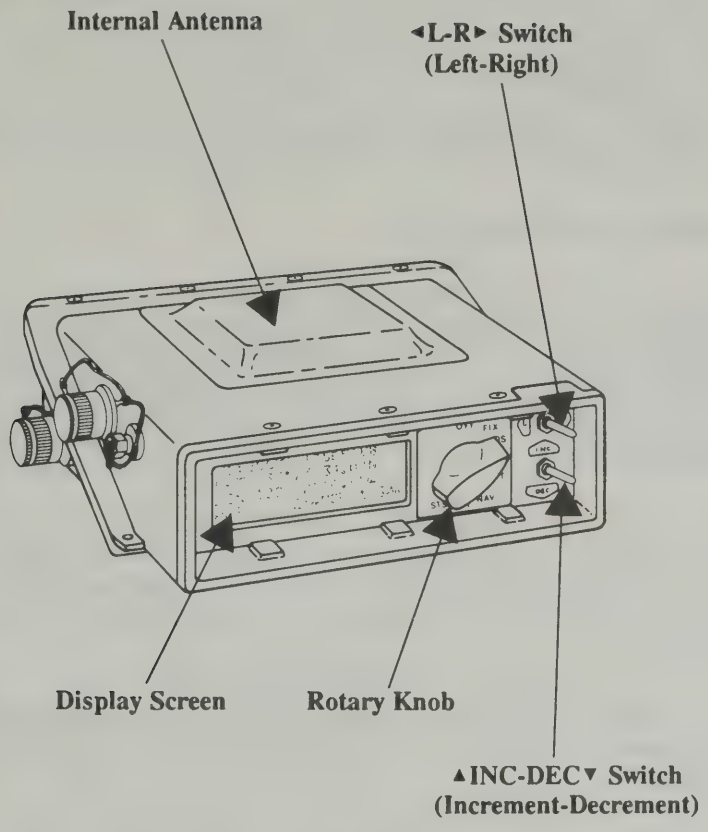


Figure 5-1. TRIMPACK Controls and Indicators

5.1.1 Display Screen

The TRIMPACK displays alphanumeric data on a 4-line, 20-character screen. The data is arranged on the screen in several formats, depending on the operating mode selected. Pressing INC-DEC during the countdown varies the screen backlight brightness to any one of four levels. The display provides desired information to the user as well as cursor position to assist in data entry and selection.

5.1.2 Rotary Switch

This 8-position switch selects the operating mode of the TRIMPACK. The positions consist of 7 operating modes and the "OFF" mode.

5.1.3 L-R (Left-Right) Switch

This center-biased, 3-position switch moves the cursor within the display to select the field when user option selection or data entry is required. The cursor moves to the next field or to the next data value within the present field each time you press the switch to the L or R position. This switch features an auto-repeat function when held continuously in left or right position. This will cause the cursor to sequence through the available screen fields continuously until the switch is released.

> **This switch is for field selection and cursor positioning only, it does not change the value of any displayed data.**

5.1.4 INC-DEC (Increment-Decrement) Switch

This center-biased, 3-position switch is used to alter values, select options, or change screens depending on the field that has been selected. If the selected field is a data field, this switch is used to sequence through numeric or alphabetic characters for selection. If the selected field requires an option selection, this switch will sequence through the options. If the selected field is the "<more>" field at the lower right corner of a display, this switch allows the user to page through additional screens (if any) associated with that rotary switch mode position.

This switch also has the auto-repeat characteristic. If the switch is held in either the INC or DEC position, the alphanumeric characters will continuously sequence until the switch is released. The rate of sequencing depends on the type of data. Large numeric fields will have sequencing at approximately 10 steps/second, whereas alphabetic characters and other single digit fields will sequence at approximately 4 steps/second.

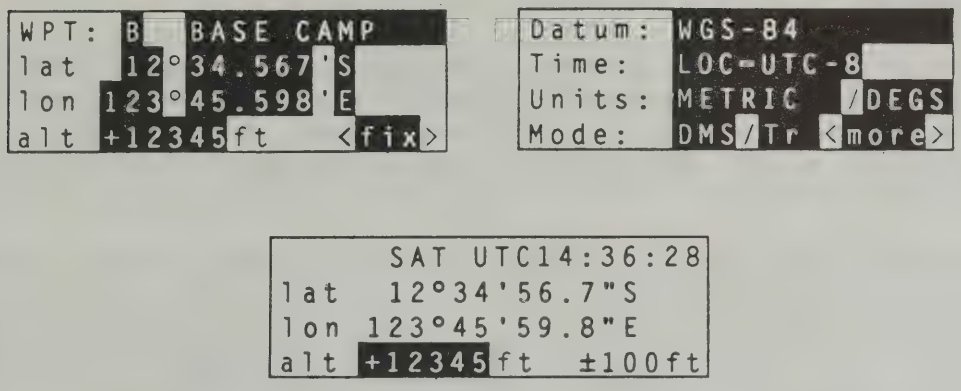
> **When a user-alterable field has been selected, use of the INC-DEC switch changes the value of stored data. Ensure that the field selection has been made properly before using this switch.**

5.2 User/Display Interaction

5.2.1 Display Fields

The display screen provides various types of information to the user in various formats depending on the display mode chosen. Some screens, along with presenting text labels and data, have fields in which the user can change the displayed value or select options. These fields are called "user-alterable fields" and are depicted on screens in this manual as reverse-video, black-background cursor positions. These are the fields (and cursor positions within the fields) which are accessed by using the L-R switch as discussed in section 5.1.3.

Typical Screens



▉ User-Alterable Field

Once a field has been selected, the INC-DEC switch is used to act on the field. This action depends on the type of field as described in section 5.1.4 and in the following sections.

5.2.2 Field Selection

When the L-R switch is used to select a user-alterable field, the field flashes. The field continues to flash until either you move the cursor to another field or 25 seconds elapse. After 25 seconds, the field selection times out, and you must use the L-R switch to reactivate a field for change. **You can change the data in a user-alterable field only by using the INC-DEC switch while the field is flashing.**

5.2.3 Next Display Selection

The NAV, OPS, and STS operating modes each contain multiple screens. The screens within each mode are linked by the <more> field in the lower right corner of the display. This field flashes for 25 seconds after you enter the screen, indicating that you can select the next or previous screen by pressing the INC or DEC switch. After 25 seconds, the screen selection times out; if you then wish to move to another screen, you must use the L-R switch to move the cursor to the <more> field and then use the INC-DEC switch to move to the next (or previous) screen.

This field is not truly "user-alterable", as is the case for the data or option fields. However, the <more> field is a "user-selectable" field and the INC-DEC switch will cause a change of screens when this field is activated.

5.2.4 Data Entry

Data entry into the TRIMPACK is required in a variety of situations. Entry of alphanumeric characters is required for waypoint definition and altitude values. The other form of data entry is the selection of user options such as datum, coordinate system and units to be used. Once a user-alterable field has been selected using the L-R switch, the field will flash for 25 seconds (see section 5.2.2) and data entry can be initiated.

Alphanumeric character entry is done by first using the L-R switch to position the cursor to the desired position within the field. The INC-DEC switch is then used to scroll forward or backward through the characters available for entry into that field location. The available characters for entry will depend on the type of data field. For example, a latitude or longitude field (for waypoint location) will cycle through only the valid numbers for entry when the INC-DEC switch is used. Similarly, an alphabetic field will only scroll through alphabetic characters.

When the end of the sequence of valid characters or numbers is reached, the sequence will recycle to the beginning. As described in section 5.1.4, when the switch is held in the INC or DEC position the sequence of entry data will scroll rapidly.

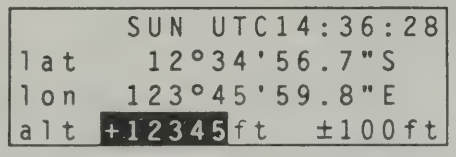
5.3 General Operation Overview

5.3.1 Operating Parameter Selection

5.3.1.1 Coordinate Systems

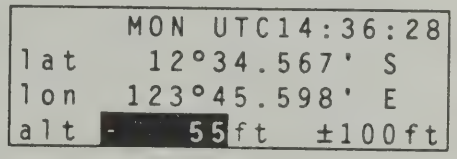
The TRIMPACK can display position information in any of four coordinate systems. The desired system can be selected from the first option screen of the STS mode. Once a coordinate system is selected, all position displays (in all modes) will be expressed in the selected system. The available coordinate systems are described below.

DMS: A Latitude/Longitude system, with position expressed in degrees (°), minutes ('), and seconds (") to a tenth of a second.



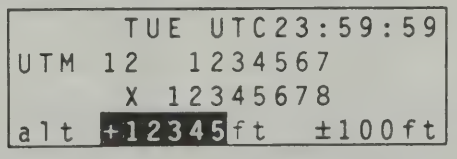
day of week & time
latitude
longitude
altitude & accuracy

DM.: A Latitude/Longitude system, with position expressed in degrees and minutes. Minutes are displayed to one-thousandth of a minute in decimal form.



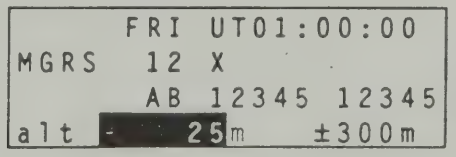
day of week & time
latitude
longitude
altitude & accuracy

UTM: The Universal Transverse Mercator coordinate system, providing the gridzone designator and the northing and easting component values of the position in meters.



day of week & time
grid & easting
zone & northing
altitude & accuracy

MGRS: The Military Grid Reference System, providing the gridzone designator, the grid square designator, and the position coordinates in meters.



day of week & time
gridzone
grid square & coordinate
altitude & accuracy

5.3.1.2 Datums

Maps are drawn based on a mathematical model of the earth's shape. This is called a datum. For the TRIMPACK's displayed position to agree with corresponding positions on a map, the datum must be selected on the TRIMPACK Setup Screen (see page 5-24) to be the same as the datum used to draw the map. The map's datum is usually indicated in the map legend or title block.

The TRIMPACK provides the ability to reference the position data to any of 50 different datums. Datum selection is done in the first option screen under the STS mode. The following table shows a list of the datums available in TRIMPACK.

Table 5-1. Datums

Ref No.	TRIMPACK Display	Datum Description
0	WGS-84	WGS-84
1	WGS-72	WGS-72
2	Adindan	Adindan
3	ARC 1950	ARC 1950
4	Australian '84	Australian Geodetic 1984
5	Bukit Rimpah	Bukit Rimpah
6	CampAreaAstro	Camp Area Astro
7	CorregoAlegre	Corrego Alegre
8	Djakarta	Djakarta
9	European 1950	European 1950
10	Geodetic 1949	Geodetic Datum 1949
11	Ghana	Ghana
12	G.Britain '36	Ordnance Survey of G.Britain1936
13	Guam 1963	Guam 1963
14	G. Segara	G. Segara
15	G. Serindung	G. Serindung
16	Herat North	Herat North
17	Hjorsey 1955	Hjorsey 1955
18	Hu-Tzu-Shan	Hu-Tzu-Shan
19	Indian	Indian
20	Ireland 1965	Ireland 1965
21	Kertau Malay	Kertau (Malayan Revised Triangulation)
22	Liberia 1964	Liberia 1964
23	Local Astro	Local Astro (user datum)
24	Luzon	Luzon

Ref No.	TRIMPACK Display	Datum Description
25	Merchich	Merchich
26	Montjong Lowe	Montjong Lowe
27	Nigeria	Nigeria (Minna)
28	NAD-27, CONUS	North American 1927 (CONUS)
29	Alaska/Canada	North American 1927 (Alaska and Canada)
30	NAD-83	NAD-83
31	Maui, Old HI	Old Hawaiian, Maui
32	Oahu, Old HI	Old Hawaiian, Oahu
33	Kauai, Old HI	Old Hawaiian, Kauai
34	Qornoq	Qornoq
35	SAD-69	South American Datum 1969
36	SierraLeon'60	Sierra Leone 1960
37	S.America '56	S.American (ProvisionalS.Am1956)
38	Prov.CorregoA	S.American (Corrego Alegre)
39	CampoInchausp	S.American (Campo Inchauspe)
40	Chua Astro	S.American (Chua Astro)
41	Yacare	S.American (Yacare)
42	Tananarive'25	Tananarive Observatory 1925
43	Timbalai	Timbalai
44	Tokyo	Tokyo
45	Voirol	Voirol
46	Indian SPCL	Indian Special (MGRS)
47	Luzon SPCL	Luzon Special (MGRS)
48	Tokyo SPCL	Tokyo Special (MGRS)
49	WGS-84 SPCL	WGS-84 Special (MGRS)

5.3.1.3 Units/Reference Options

Other user-selectable operating parameters consist of measurement units and reference options. These options are specified in the first option screen of the STS operating mode. Table 5-2 describes the units and reference options available.

Table 5-2. Units Options

Dimension	Available Choices
Time	LOCal (operator inputs time zone offset) UTC
Distance Units	METRIC (meters, kilometers, km/hr) ENGLISH (feet, miles, miles/hr) NAUTICAL (feet, nautical miles, knots)
Angular Units	DEGREES MILS (6400 mils/circle) RADIANS
Azimuth Reference	TRUE NORTH MAGNETIC NORTH

Selection of these options is done by activating the option field using the L-R switch, then toggling the INC-DEC switch until the desired value is shown.

5.3.1.4 Common Navigation Parameters

Common definitions of navigation parameters have been used in the design of the TRIMPACK (reference Appendix C, Abbreviations Glossary).

5.3.1.5 Waypoint Entry

Waypoint entry is done under the WPT mode. This mode will display user entered three-dimensional waypoints in the coordinate system currently selected (see section 5.3.1.1). In this mode, the user can review and/or modify waypoints to be used for navigation. The waypoints are designated by a single alphabetic character, providing 26 available waypoints. The screen also offers a waypoint identification label field for further waypoint description.

5.3.2 Positioning and Navigation Scenarios

5.3.2.1 Position Determination

The TRIMPACK will display GPS-calculated position coordinates in the FIX and POS operation modes. The FIX mode will display position solutions for 30 seconds then the receiver will automatically turn itself off. The POS mode will display position solutions until another display mode is selected. (See sections 5.4.3 and 5.4.4 for a detailed description of these display modes.)

Position solutions are updated at approximately 1 second intervals and are displayed in the coordinate system option selected at that time. If position solutions are not currently available, the last previously computed solution will be displayed with the indication that the fix is "OLD" in the lower right corner of the screen.

2-D/3-D Operation

In normal operation, the TRIMPACK uses signals from 4 satellites (Space Vehicles or SVs) to provide position fixes in 3 dimensions (horizontal position and altitude). If only 3 SVs are available, the calculated positions are limited to horizontal, 2-dimensional, coordinates (no altitude) and the altitude label flashes. In this mode, the accuracy of the fix depends on an accurate estimate of the altitude, whether from the previous position or operator entry. When alt flashes, it indicates that the altitude shown is being used for 2-D operation and should be verified or changed by the user.

If the TRIMPACK has been receiving signals from 4 SVs and loses contact with one of them, it switches from 3-D to 2-D operation. If you do not enter a new altitude value within 30 minutes, or if you move more than about 1 mile from the position of the last 3-D fix, the position display flashes to indicate that you should enter an altitude. When 3-D fixes resume, the TRIMPACK disregards the value you entered and displays the GPS-calculated altitude.

The altitude entry procedure is described in detail in the POS operating mode, section 5.4.4.

Position Averaging

When the TRIMPACK is stationary, an averaging feature can be enabled which provides a more stable, time-averaged estimate of the position. The averaging feature is enabled from the averaging option screen under the OPS display mode. Once enabled, the position displayed in FIX and POS modes will reflect the averaged value and all navigation data will be generated from the averaged position. The position and navigation displays will indicate that averaging is enabled by displaying "AVG" in the upper left corner of the display. If the upper left corner is occupied by another word, such as "TO", then "AVG" will be alternately displayed. The result will be the simple arithmetic average of the measurements made during the averaging period.

Accuracy

The accuracy of the GPS-calculated position is influenced by the geometry of the constellation of satellites being used for the solution. An accuracy figure is provided on the position and fix screens in the form of a distance (feet or meters). The position fix is accurate to within this distance. The accuracy figure is computed from the PDOP of the constellation being used and the user ranging accuracy (URA) transmitted by the satellites and rounded up to the values shown in Table 5-3.

Table 5-3. Rounded Accuracy Figures

Units	Rounded Values of Displayed Accuracy Figure				
Metric	±30m	±100m	±300m	±1000m	±***
English	±100ft	±300ft	±1000ft	±3000ft	±***
Nautical	±100ft	±300ft	±1000ft	±3000ft	±***

*Indicates a value larger than 1000m or 3000ft.

The accuracy number is displayed in the lower right corner of the FIX or POS screens. When the TRIMPACK is not doing position fixes, the most recent position fix remains displayed and the accuracy indicator is replaced by the blinking message OLD. The accuracy indicator is replaced by the measurement count in averaging mode, or the message "STATIC" when in one of the static timing output modes (see Appendix D).

5.3.2.2 Range and Azimuth to Waypoints

The R+A mode provides bearing (azimuth), range, and vertical difference between the current (or last calculated) position and each of three user selected waypoints. This provides the user a quick navigation reference to three locations of interest.

5.3.2.3 Waypoint Navigation

Waypoint navigation is provided under the NAV display mode. The navigation data is referenced to the waypoints selected by the user on the navigation screen of choice. The types of navigation screens available and the navigation data available are summarized in Table 5-4.

Table 5-4. Navigation Data Available

Navigation Data Available	Navigation Type			
	Pioneer	Intended Track	3-D Homing	Vehicle Navigation
Range	√	√		√
Slant Range			√	
Azimuth	√	√	√	√
Steering Angle, Horizontal	√	√	√	
Steering Angle, Vertical			√	
Cross-track Error		√		
Vertical Difference			√	√
Speed				√
Course				√
Time to go			√	√

These navigation display modes are discussed in detail in section 5.4.6.

Figure 5-2 shows how the present position is used to derive the range (rng) and azimuth (azm) to the destination and how the velocity is used to find the relative steering angle.

When a "from" waypoint is specified, the cross-track error (*xte*) is calculated as the perpendicular distance from the unit's position to the straight line track between the source and destination.

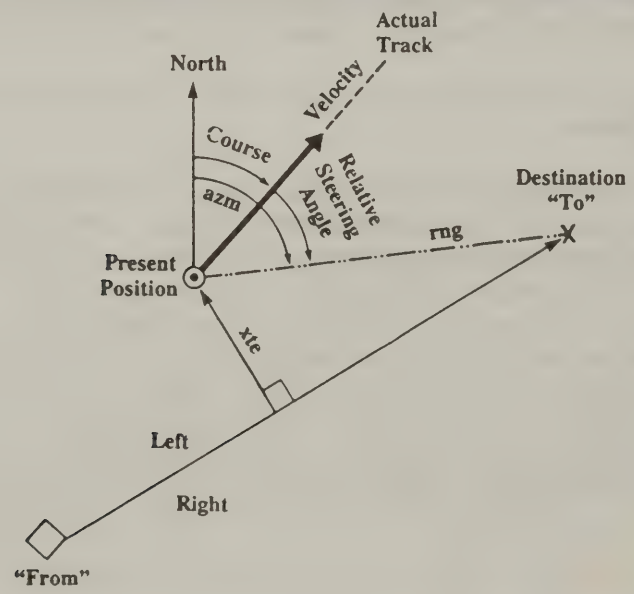


Figure 5-2. Derivation of Range, Azimuth and Relative Steering Angle

Figure 5-3 shows how the vertical (3-D) data from position and velocity is used to derive the vertical difference (*vrt*), slant range (*srg*), and relative climb angle.

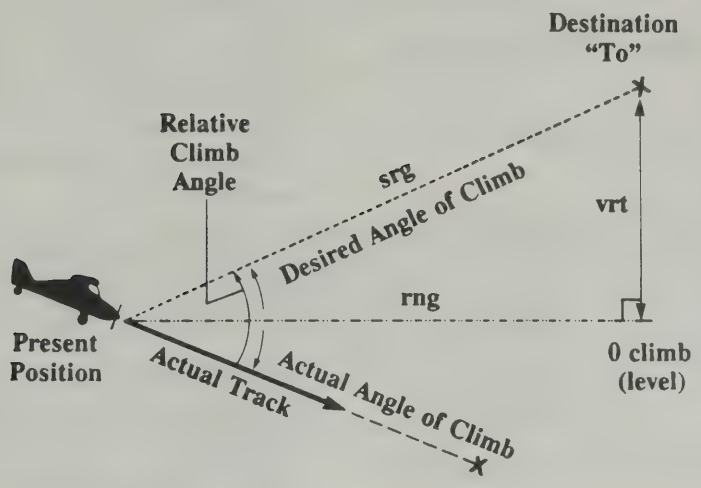
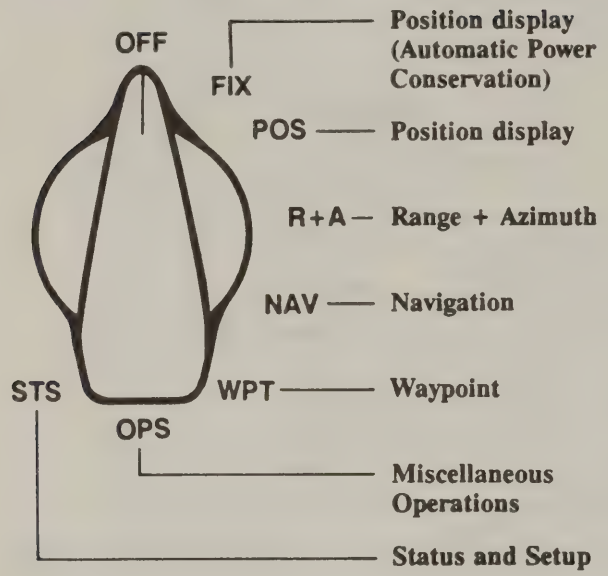


Figure 5-3. Derivation of Vertical Difference,Slant Range and Relative Climb Angle

5.4 Operating Modes

5.4.1 Mode Selection



The TRIMPACK can be operated in several modes. The operating mode is selected by turning the rotary switch to one of its 8 positions. The following is a brief description of each of the 8 display modes. A detailed description of each display mode is located in the subsequent sections of this manual.

OFF: The TRIMPACK will turn off when in this position. Rotating the switch to any of the other positions turns the unit on.

FIX: The TRIMPACK acquires satellite signals, computes a position fix (usually within 3 minutes) and displays it for 30 seconds, after which it automatically powers down.

Figure 5-4. Mode Selection Switch

POS: Similar to the FIX mode, except that the computed position fix remains displayed until another mode is selected.

R+A: Displays the range, azimuth, and vertical difference from your present position to any 3 waypoints on a single screen.

NAV: Provides steering and other navigation data relative to user-selected waypoints. There are four types of navigation screens available: Pioneer, Intended Track, 3-D Homing, and Vehicle Navigation.

WPT: Enables the user to enter waypoint designators and coordinate data for up to 26 waypoints.

OPS: Provides selectable functions that support other operating modes: COPY, CALCulate, DISTance, and AVERAGING.

STS: Provides current status information concerning GPS reception and TRIMPACK maintenance condition; it also enables you to select operating parameters for the required application and communicate over the digital data port with other TRIMPACKs.

The NAV and OPS modes each have 4 selectable screens; the STS mode has 3 screens; all other modes have a single screen. The modes with multiple screens will have the <more> field in the lower right corner of the screen. This field may be selected using the L-R switch, then screen change is done using the INC-DEC switch.

5.4.2 ON/OFF

When you turn the TRIMPACK on by turning the rotary switch to one of the operating mode positions, two brief sign-on messages are displayed. No switches are active during this short time. When the power-on sequence is completed, the rotary switch position determines the mode of operation.

```
 Trimble Navigation
----- TRIMPACK -----

                v1.23x
```

(displayed briefly)

software version

Memory Erase Function

The memory erase function allows the user to instantaneously erase all operating information stored in the TRIMPACK. This information includes GPS ephemeris and almanac data, user operating parameter options, and all waypoint information. The TRIMPACK will set all parameters to default values and be required to re-collect almanac and ephemeris data from the satellites or downloaded from another TRIMPACK before solutions are available.

Activate the function by holding the L and INC switches while turning the rotary switch to the OFF position.

CAUTION

Use this function only when absolutely necessary. All waypoints, the stored almanac, the time clock, and the last fix are erased from memory. All fields in the 26 waypoints are set to zero. After erasing the memory, the receiver has no knowledge of satellite location; the time required to compute the next fix may be as long as 20 minutes.

When you turn the rotary switch to OFF, the screen displays a 15-second countdown to power off. During the 15 seconds, you can return the TRIMPACK to full operation instantly by turning the rotary switch to another position. The TRIMPACK will continue to track satellites during this 15 second countdown period.

```
-OFF in 15 seconds-

 INC/DEC backlight
```

(counts down for 15 seconds)

The backlighting intensity can be changed during countdown by using the **INC/DEC** switch to select one of the four backlighting levels. The TRIMPACK powers up with backlighting off.

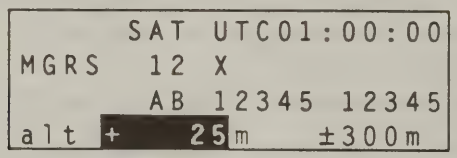
5.4.3 FIX

The FIX mode is intended as a power saving method that displays a position fix for 30 seconds after a position is computed and then automatically powers down the TRIMPACK. If a position cannot be obtained, the TRIMPACK powers down after 5 minutes. During the last 30 seconds, the top line of the display flashes a countdown message.

5.4.4 POS

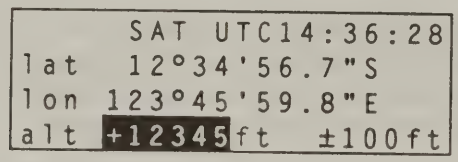
The POS (position) mode displays GPS position solutions as they are computed by the TRIMPACK. If GPS solutions are not available, the last previously computed position will be displayed with "OLD" displayed in the lower right corner of the screen. This screen is identical to the FIX mode screen except that, in the POS mode, the position display remains until another mode is selected.

(MGRS format shown)



day of week & time
gridzone
square & coordinate
altitude & accuracy

(DMS format shown)



day of week & time
latitude
longitude
altitude & accuracy

Line 1 of the display shows the day of the week and the time (a 24-hour clock is used) in either UTC or local time. Local time is not labeled.

Lines 2 and 3 show the position coordinates in the selected system (DMS, DM., UTM, or MGR).

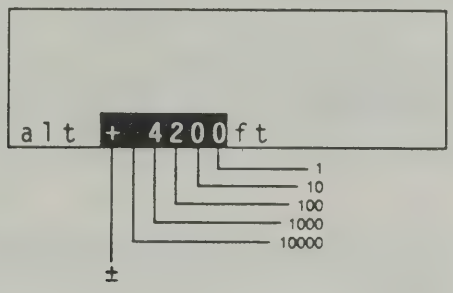
Line 4 shows the altitude in meters or feet and an estimated accuracy indicator (or OLD or number of averages).

When the TRIMPACK is providing 2-D fixes, the alt label will alternate between "alt" and "2-D." If the TRIMPACK has moved more than 1 mile horizontally or 30 minutes have passed since the last user-entered or GPS altitude, then the altitude field will begin to blink. This alerts the user to check the altitude.

Entering Altitude

If the TRIMPACK is providing 2-D fixes, you should manually enter an altitude. The altitude data field contains a 5-digit number preceded by a sign to indicate above (+) or below (-) sea level. Select the data field by using the L-R switch.

Enter the proper sign by toggling the INC switch, then use the R switch to move to the first non-zero digit and toggle in the desired value. If the remaining digits are zeroes, you are done; if other values are required, continue with the R and INC switches until all non-zero values are displayed. A built-in validity check only allows altitudes between -500m (-1600ft) and +20000m (65000ft) to be entered. Altitudes outside this range are rejected.



Example:
To set altitude to 4200 feet:

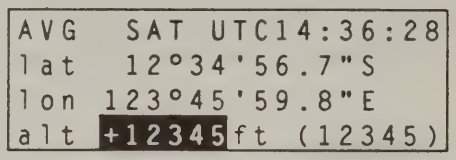
- move to ± position and toggle to +
- move to 10,000 position
  - if it already contains a value, set it to 0
  - if it is already at 0, ignore it
- move to 1,000 position and set it to 4
- move to 100 position and set it to 2
- if either the 10 or the 1 position already contains a value, set it to 0; if it is already at 0, ignore it

NOTE: Altitude cannot be entered if the averaging mode is in effect.

Averaging

The Averaging function averages the current position with previous fixes approximately once each second to obtain a more accurate fix. The TRIMPACK must remain stationary during averaging. When Averaging is enabled (see OPS mode, page 5-21), the top and bottom lines of the FIX mode screen are modified. The label AVG appears in the top left corner to indicate that position fixes are being averaged; on the bottom line, the accuracy indicator is replaced with the number of position fixes averaged since the function was enabled. Turn Averaging off when not in use or when in motion. The FIX display when averaging is in use is displayed below. The TRIMPACK will still turn off after 30 seconds. Use POS mode for averaging.

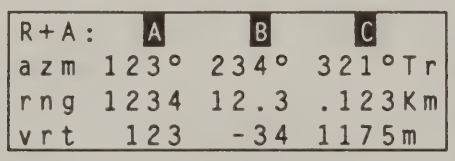
Averaging Indicator



number of fixes averaged

5.4.5 R+A

The R+A (Range & Azimuth) mode displays the range, azimuth, and vertical difference from your present position to any 3 of the 26 waypoints (A-Z).



3 destination waypoints
azimuth
range
vertical difference

You can display any waypoint in any of the 3 positions. Use the L-R switch to move the cursor to the appropriate position and the INC-DEC switch to select the desired waypoint identification letter. The TRIMPACK recalculates and displays the new range, azimuth, and vertical difference to the selected waypoints.

The range is the Great Circle distance from the present position. The vertical height difference can range from 0 to 9999 feet or meters. When a range or vertical difference exceeds 9999, an asterisk (*) is displayed. A negative vertical difference means that the destination waypoint is at a lower altitude than your present position. The azimuth can be displayed in mils, degrees, or radians (selectable as described in paragraph 5.3.1.3) and can be referred to either True or Magnetic North.

If the TRIMPACK is not doing position fixes, the R+A label alternates with the word OLD. If the TRIMPACK is in the Averaging mode, the R+A label alternates with AVG. If the TRIMPACK is performing 2-D fixes, the vrt label alternates with 2-D.

5.4.6 NAV

The NAV (Navigation) mode displays data to help you navigate from your present position to another position. One of 4 navigation screens can be used, depending on your specific application.

When you select the NAV position, the TRIMPACK automatically returns to the most recently used navigation screen. If you wish to use a different screen, use the <more> field to select the desired screen.

In each navigation screen, you need only enter your destination waypoint. The TRIMPACK automatically displays the data you need to navigate to that point from your present position.

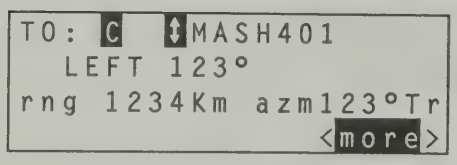
On all four screens, if the TRIMPACK is not doing position fixes, the TO: label alternates with the word OLD. If the TRIMPACK is in the Averaging mode, the TO: label alternates with AVG.

Alphabetic Search: On all NAV and WPT screens, an "up/down" arrow symbol appears when the waypoint field is highlighted, indicating that you can scroll through the waypoint labels alphabetically in either direction. Use the <L-R> switch to select the up/down arrow and the "INC-DEC" switch to scroll through the labels. The "Pioneer" NAV screen shows an example of the up/down arrow symbol in line 1.

Pioneer Mode: This display provides the basic information required when you are traveling to your destination on foot. Only your selected destination waypoint and label, relative steering angle, range, and azimuth are displayed.

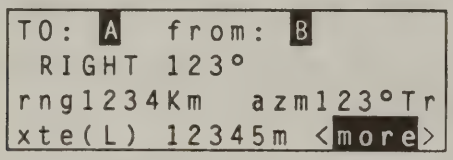
NOTE: If the TRIMPACK is stationary, the steering angle is not computed. The last steering angle is displayed, but is blinking. The TRIMPACK must be moving faster than 0.6 m/sec to compute horizontal steering angle.

NOTE: XTE is shown in feet or meters if it is less than 2400 ft (600 m), or in miles, km or naut. miles for longer distances.



destination wpt & label
relative steering angle
range & azimuth

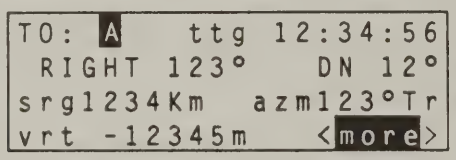
Intended Track Mode: This display format assumes you wish to cross an area on a narrowly defined path. You must enter both a destination waypoint (TO:) and a starting waypoint (FR:). The starting waypoint may be your present position (indicated by an *); the label "Pos-at-start" appears. Then the relative steering angle (see note above), range, azimuth, and cross-track error are shown. The distance your present position is to the left or right of the intended track is indicated by xte(L) or xte(R).



destination & starting wpts
relative steering angle
range & azimuth
cross track error

While entering "From" waypoint:

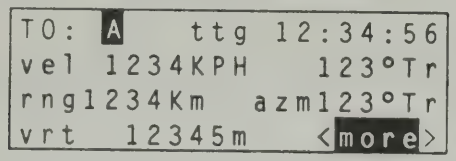
3-D Homing Mode: A typical user might be a parachutist who requires 3-dimensional information. When a destination waypoint is selected, its label briefly replaces the time-to-go data. After entry, the time-to-go display reappears, along with the horizontal and vertical steering angles, slant range, azimuth and vertical difference to the destination waypoint. The TRIMPACK must be moving more than 6 m/sec to display vertical steering angle.



destination waypoint & time to go
relative steering angles
slant range & azimuth
vertical difference

Vehicle Navigation Mode: Line 1 shows the destination waypoint and its associated label during entry; time to go replaces the label after entry of the selected waypoint. Line 2 shows your velocity and course. The range and azimuth to your destination are shown on line 3, and line 4 shows the difference in altitude between present position and your destination.

If the position fixes are in 2-D, the vrt label for vertical difference (on 3-D Homing and Vehicle Navigation displays) alternates with 2-D. Negative vertical differences indicate that the destination waypoint has a lower altitude than your current position.



destination waypoint & time to go
vel & course over ground
range & azimuth
vertical difference

5.4.7 WPT

The WPT (Waypoint) mode enables you to enter data to define up to 26 separate waypoints (A-Z) and display and edit the data for any waypoint. All waypoints are displayed in the chosen coordinate system.

Each field of the WPT display can be altered without affecting any other field. Each field has a range of allowable values. If you INC up to the maximum value in a field, the next increment returns to the minimum value. Similarly, decrementing through the minimum value wraps back to the maximum.

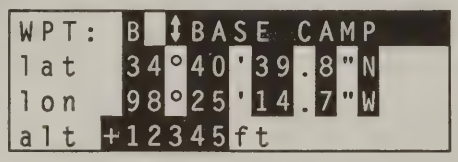
When you alter a waypoint, an <enter> field appears in the bottom right corner of the screen. To store the waypoint in memory, select the <enter> field and press INC. If an error is detected, the waypoint is not stored and an error message is displayed.

The user label is up to 12 characters of alphanumeric data which describe or identify the associated waypoint. You can create the label by moving the cursor to each character position and scrolling through the character set by using the INC-DEC switch. The labeled waypoint then becomes accessible through the use of the "↕" alphabetic search.

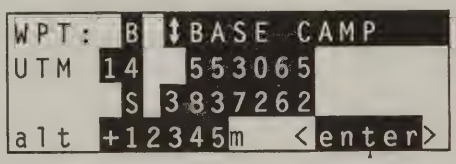
To copy the current position fix into a waypoint, the bottom right corner of the display contains a <fix> field. When you select the <fix> field and press INC, the data from the present position fix is loaded into the next available "empty" waypoint (or the selected waypoint if it is already empty). The last 6 characters of the label reflect the time (time is always displayed as UTC in this mode) and date (hh [hours], mm [minutes], and dd [day of the month]). The <fix> field is not displayed if the TRIMPACK is not tracking enough satellites to obtain fixes. The <fix> field is replaced by <avg> when averaging.

DMS Format

wpt desig. & label
latitude
longitude
altitude



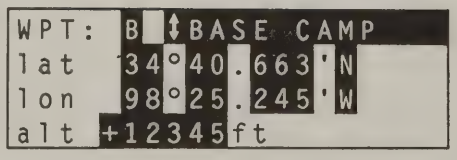
UTM Format



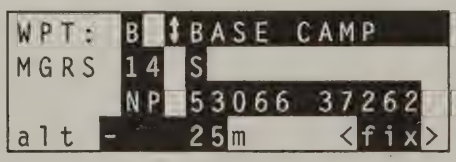
wpt desig. & label
grid zone & easting & northing
altitude

DM. Format

wpt desig. & label
latitude
longitude
altitude



MGRS Format



wpt desig. & label
gridzone square & coord.
altitude

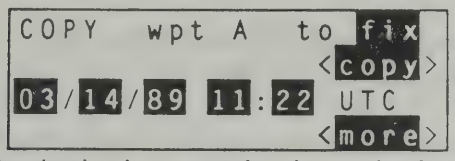
5.4.8 OPS

The OPS (Options) mode provides 4 selectable functions that are useful in support of other operating modes. The data for each function is displayed in a separate screen. The 4 screens are accessed by the <more> field.

COPY Function

The source field cycles from A through Z and FIX (which is the most recent position calculated by the receiver). When you select the <copy> field and press the INC switch, the data from the source waypoint or FIX information is copied to the selected waypoint. The selected waypoint is automatically incremented to the next waypoint for ease in copying data to multiple waypoints. Copying data to multiple waypoints is useful, as it is easier to modify existing fields than to start from all zeros.

COPY to FIX



source and destination
copy waypoint trigger
date/time for Copy to "fix"

The destination waypoint also cycles from A through Z and FIX. When FIX is the destination, date and time fields will appear on the third line with the current data and time from the real time clock. The user can modify the date and time fields if necessary and use the "<copy>" field to initialize the TRIMPACK acquisition algorithm. The date and time entry is always in UTC. The COPY into FIX function will restart the software.

CAUTION

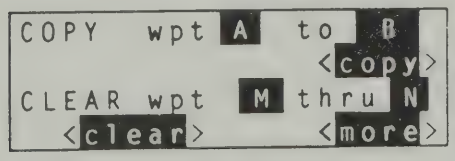
TRIMPACK DOES NOT **require initialization. The "COPY into FIX" function initializes the TRIMPACK with location/date data, and should be used with caution.**

CLEAR FUNCTION

The CLEAR function on the third and fourth lines allows the user to clear any contiguous range of waypoints as defined by the two user-alterable fields. The first waypoint field must be between the beginning of the alphabet and the second waypoint field.

The function is performed by selecting the "<clear>" field and pressing **INC**.

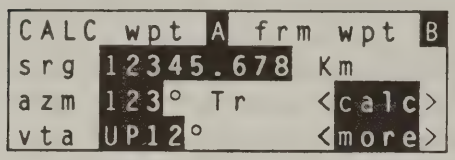
COPY and CLEAR FUNCTION



source and destination
copy waypoint trigger
waypoints to clear
clear waypoint trigger

CALC Function

The Calculate function is used to generate a position from any one of the stored waypoints and a slant range, azimuth, and vertical angle input; the result is stored in a selected waypoint. The calculated position values overwrite any previous data contained in the selected waypoint. Be sure the vertical angle is set to zero before calculating a new position that is at long range. The starting waypoint can also be the present GPS position, as indicated by "FIX."

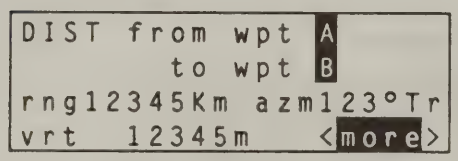


waypoint loaded with result & starting wpt
entered slant range
entered azm & funct. trig.
entered vertical angle

DIST Function

The Distance function is used to find the range (Great Circle range in selected datum), azimuth, and vertical difference between any two selected waypoints.

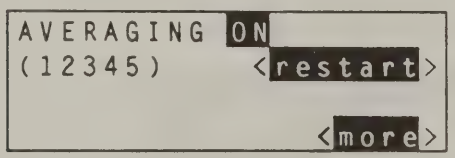
Either of the starting or ending waypoints can be set to the current GPS position (indicated by "FIX"). When the ending is set to FIX, the displayed data is the reverse course to the starting waypoint.



starting waypoint
ending waypoint
range & azimuth
vertical difference

AVERAGING Function

This function can be toggled ON and OFF by selecting the field and then using the INC switch. Use the <restart> field to restart the averaging process. Averaging requires the TRIMPACK to be held stationary. Turn off this function when not in use. (See page 5-16 for more information.)



averaging on/off
number of positions
averaged & restart trig.

5.4.9 STS

The STS (Status) mode provides continually updated status information concerning GPS reception and condition of the TRIMPACK (Status screen), allows selection of the reference datum, operating parameters, and the coordinate system to be used for your mission (Setup Screen), and enables control of communication between the TRIMPACK and a data loader or another TRIMPACK (Data Communication Screen).

The 3 screens are linked by the <more> field.

STATUS Screen

The Status screen shows GPS and TRIMPACK status only; it contains no user-alterable data fields.

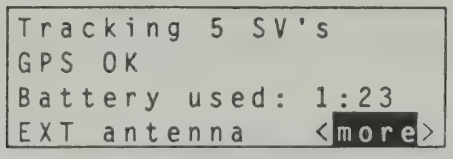
The first line shows the number of SVs (Space Vehicles) currently being tracked by the TRIMPACK; the number may be 0 if there are no visible or usable satellites.

The GPS status message shows the condition of the reception of the GPS data from the SVs. Conditions include GPS OK, GPS N/A (not enough visible or usable SVs), GPS BAD (bad geometry, SV health, or some other reason why position fixes are not possible), RECEIVER FAULT (service required), or MEMORY RESET (memory erase function used).

Line 3 shows time of operation in hours:minutes of the batteries since the battery pack was last attached. See page 6-3 for typical operating life.

NOTE: Battery timer will reset when the battery pack is removed and external power dust cap is in place. To ensure timer reset, the battery pack should remain off for approximately 5 minutes or the receiver power should be cycled with the battery pack off.

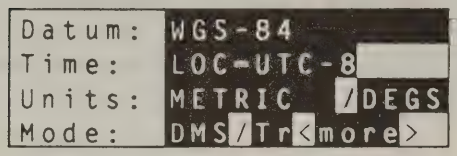
The last line shows whether the INTernal or an EXTernal antenna is being used.



satellite status
condition messages
elapsed battery usage
antenna in use

Setup Screen

This screen allows you to set output parameters according to your requirements. To change any of the parameters, use the L-R switch to move the cursor to the appropriate field and use the INC-DEC switch to make your selection.



datum
local time offset
dist units & azm style
coord. style & azm mode

Datum: Line 1 shows the datum selection. You may select any of the 50 datum choices built into the TRIMPACK (see page 5-6 for the complete list). For TRIMPACK position fixes to agree with a map, the TRIMPACK datum must match the datum shown on the map.

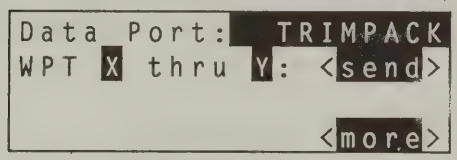
Time: Line 2 enables you to select either UTC or LOC time and to enter the local time offset value (LOC = UTC ± offset).

Units: Line 3 identifies the units in which distances and velocities (METRIC, ENGLISH, or NAUTICAL) and angles (DEGS, MILS, or RADS) are displayed.

Mode: Line 4 shows the selected coordinate system (DMS, DM., UTM, or MGR) and azimuth reference (True or Magnetic).

Data Communication Screen

These options control the communication between the TRIMPACK and a data loader or another TRIMPACK.



data port protocol name
waypoint sending controls

Data Port: Select the data port protocol name from either "TRIMPACK," "TPACK-2," or "OFF." TPACK-2 sends unique data for post processing differential corrections, and is not used in normal operation.

The second line enables you to select (when this field is activated) the type of data to be sent to another unit: waypoints, almanac data, or setup parameters. When sending waypoints, the range of waypoints (for example A - D) can be selected; only waypoints within that range that contain data are transmitted. The selected data is sent when the <send> trigger at the end of line 2 is activated.

NOTE:
- No empty waypoints may be included in the range of waypoints to be transferred from a 3-channel TRIMPACK to a 2-channel TRIMPACK.
- Only the first 26 waypoints can be transferred from a TRIMPACK with the 1089-Waypoints option to a standard 26-waypoint TRIMPACK.

-sending-: Indicates data is being sent to an external device or an error message ("?" or "-ABORTED-") if the data transfer fails.

The TRIMPACK data communications port supports the protocol described in Appendix A. The primary applications supported are for TRIMPACK to TRIMPACK communications and data recording. See paragraphs 7.1.1 and 7.4 for interconnecting cables available from Trimble.

5.5 TRIMPACK to TRIMPACK Communications

This capability allows a TRIMPACK to transfer all information required for initialization to another TRIMPACK. All setup parameters, almanac data, initial position and current time can be transferred as well as any or all waypoints. The transmitted information will overwrite the receiving TRIMPACK's waypoints, almanac or setup state.

This process requires a Data Port selection of "TRIMPACK" on the STS Data Communication Screen.

Any contiguous string of waypoints can be sent by choosing the first and last waypoint on the second line of the Data Communication Screen. The waypoint fields are always described in ascending order; e.g., if the first waypoint is K, only K through Z are allowed in the last waypoint field. The cursor is moved to the <send> field and INC is pressed to start the transfer. The fourth line will show "-sending n-" where n is the alpha waypoint designator currently being sent. If the transfer fails the "n" character will be replaced by "?" followed by "-ABORTED-".

If downloading to an earlier generation TRIMPACK (P/N 12545-00), there must be no blank waypoints in the range of waypoints selected.

The second line of the STS Data Communication Screen also allows transfer of almanac or setup parameters. When "Almanac" is selected the entire almanac for the space segment as currently stored in the sending TRIMPACK is transferred along with the health page, UTC and ionospheric corrections, current or last stored position and current time. The "-sending n-" message indicates the page number currently being transferred. A complete transfer consists of 35 pages and requires approximately 30 to 45 seconds. Selecting "setup parms" allows transfer of the entire contents of STS Setup Screen as defined above. This supports copying of all user-entered measurement conditions.

6.0 SPECIFICATIONS AND STANDARDS

6.1 Performance Specifications

6.1.1 Acquisition and Navigation Performance

Reaction Time. Reaction time (REAC) is defined as the elapsed time from turning on the TRIMPACK to the first display of position. REAC is less than 4 minutes under the conditions specified below under "Conditions of this Specified Quality". Section 4.1 gives a more detailed description of the acquisition process.

Initialized Reaction Time. Initialized reaction time (IREAC) is defined as the elapsed time from powering the system to the first display of position and velocity assuming the system is fully initialized (i.e., ephemeris and position are current). IREAC is less than 2 minutes under the conditions specified below under "Conditions of this Specified Quality".

Conditions of this Specified Quality

- The initial position uncertainty is within 1000 Km.
- The system real time clock is correct within 60 seconds.
- Current almanac is resident in system RAM.
- At least 3 satellites are available that satisfy the Trimble default system masks for GPS solution.

Position Accuracy. The position accuracy of the TRIMPACK solution is 25 meters (SEP) under steady state conditions and the conditions stated below (excludes degradation due to Selective Availability).

- Tracking 3 or more healthy satellites that satisfy the system solution masks.
- Position Dilution of Precision (PDOP) of 6 or less.
- Selective Availability of Accuracy not enabled

Velocity Accuracy. Velocity accuracy is within 0.2 meters/second RMS under steady state conditions and the conditions stated below.

- Velocity greater than 1 m/s.
- Selective Availability of Accuracy not enabled

Dynamics. TRIMPACK will track satellites and perform GPS solutions under dynamics described below.

- User velocity of less than 300 m/s (~600 knots)
- User acceleration of less than 2 g's (19.5 m/s/s)

6.1.2 Battery Operation Performance

Power Consumption. The TRIMPACK nominally consumes approximately 3.5 Watts regardless of the mode or function in which it is operating. Small variations in this value are caused by temperature and input voltage as shown in Figure 6-1 below.

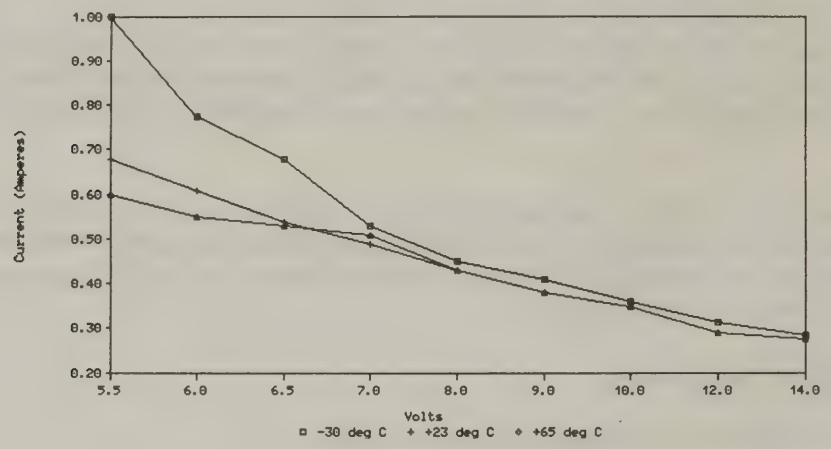


Figure 6-1 Typical Input Current vs. Input Voltage vs. Temperature

Battery Power Available. The TRIMPACK has two interchangeable different battery packs which are all interchangeable. These battery packs are described in the following table.

Table 6-1 Nominal Ampere Hours Available Over Temperature for Various Battery Packs

Type	Compatible Batteries	Energy Available from Batteries			Loaded Voltage	Number of Batteries
		AH @ -30°C	AH @ +23°C	AH @ +65°C		
2 cell pack	BA-5800	4.2	7.5	6.4	10.5	2
Rechargeable	Built-in case, non-removable NiCad cells	1.5	2.5	2.3	8.4	1

Operating Time Using Batteries. The operating time which can be obtained from the prime or optional battery packs is shown in Table 6-2. These are computed estimates of operating life based on assumed power available from specific batteries. These times should be used only as a guide until field experience or actual battery life tests are conducted. The estimate of validity of the battery life shown is ±15%.

Table 6-2 Estimated Operating Time

Type	Battery Type	Life Expectancy, Continuous Operation			Life Expectancy, Operation @ 4 Fixes/Hour*			Weight of Spare Battery Set	
		-30°C (Hours)	+23°C (Hours)	+65°C (Hours)	-30°C (Hrs/Fixes)	+23°C (Hrs/Fixes)	+65°C (Hrs/Fixes)	Pounds	Grams
2 cell pack (military)	BA-5800+	9	21	18	45/180	105/420	90/360	0.98	436
Rechargeable (commercial)	2 ea. NiCad Half D Cells	3	6	5	15/60	30/120	25/100	1.23**	560**
8 cell pack (commercial)	AA Alkaline	***	3	***	***	15/60	***	1.5	681

NOTES:

* Average of 2.65 minutes/fix based on 50% of TTFF is 1.5 minutes, 40% of TTFF is 3.5 minutes, and 10% of TTFF is 5 minutes.

** Batteries built in pack - not customer replaceable.

*** Alkaline battery operating termperature range is specified from -5° to +45°C. To prevent potential battery leakage, do not exceed these limits.

+ U.S. Government and NATO stock listed batteries. Not commercially available.

6.2 Environmental Specifications

The environmental conditions in which TRIMPACK operates are described in the following paragraphs, along with the type of test run to verify each condition. Refer to Trimble Test Report # 92301, *TRIMPACK Environmental Test Report*, for the actual test procedure and the summary results.

Thermal Design. The low power consumption allows TRIMPACK to operate over the specified ambient temperature range. Solar gain was verified by analysis. TRIMPACK will operate in direct sunlight for at least 50 minutes at ambient temperatures of 45°C. If internal temperatures exceed 85°C, the reliability of the product will be reduced but when cooled to operating range of the oscillator it will work per the specification. Immediate, permanent damage, other than to the installed batteries, is not anticipated.

WARNING

Lithium batteries can be dangerous at elevated temperatures. To prevent explosion, the Lithium battery packs contain thermal fuses which open at elevated temperatures. If the TRIMPACK does not operate after exposure to out of specification conditions, change battery pack and functionally retest.

Operating Temperature. The TRIMPACK operates without degradation over the temperature range from -30°C to +65°C while providing navigation performance in accordance with this specification. Test method: MIL-STD-810D, Method 501.2 and 502.2 (High and Low Temperature).

Non-Operating Temperature. The TRIMPACK can be stored (non-operating) without damage at temperatures between -55°C and +85°C. Test method: MIL-STD-810D, Method 501.2 and 502.2 (High and Low Temperature).

Vibration, random. TRIMPACK functions in accordance with this specification at random vibration levels of 0.02 g^2/Hz power spectral density over a frequency range of 12 to 300 Hertz and -5 dB/octave from 300 Hz to 1200 Hz. Test method: MIL-STD-810D, Method 514.3, Procedure I.

Vibration, sine. TRIMPACK functions in accordance with this specification while being exposed to low frequency sine sweep vibration. The frequencies and levels are 5 to 7 Hertz, 1 inch double amplitude, 7 to 40 Hertz 2.5 g, 40 to 50 Hertz at 0.033 inch double amplitude and 4.2 g for a sine sweep of 50 to 500 Hertz. Test method: MIL-STD-810D, Method 514.3 and Trimble procedure.

Altitude. TRIMPACK satisfies the performance requirements of this specification while operating at altitudes from -400 meters to +15,000 meters MSL (-1,300 feet to +48,750 feet). Test method: MIL-STD-810D, Method 500.2, Procedure II.

Temperature and Altitude Combination. TRIMPACK satisfies the performance requirements of this specification when exposed to the combined temperature and altitude environments described in MIL-E-5400T, Class 1, Curve A, Figure 3, Temperature vs. Altitude for Class 1 Airborne Electronic Equipment. Test method: Trimble procedure section 19 of TTP-92201.

Humidity. TRIMPACK withstands the effects of humidity up to 100 percent, including conditions wherein condensation takes place in and on the equipment. The equipment withstands the above conditions during operating and non-operating conditions. To preclude performance degradation due to moisture in the external antenna/preamplifier, the cavity is sealed containing dry inert gas. Test method: MIL-STD-810D, Method 507.2 (Induced Cyclic and Natural High Humidity).

Mechanical Shock. TRIMPACK withstands mechanical shock which is a sawtooth pulse of 40 g's for 11 ms while operating. These shocks are applied in the X, Y and Z axes of the TRIMPACK. TRIMPACK withstands mechanical shock which is a sawtooth pulse of 75 g's for 6 ms non-operating. Shocks are applied along the X, Y and Z axes of the TRIMPACK. Test method: MIL-STD-810D, Method 516.3, Procedures I and V.

Transit Drop Test. TRIMPACK withstands being dropped from 48 inches to solid plywood surface over concrete. Drops are done on all faces, all edges and all corners (6 faces, 12 edges, and 8 corners). The TRIMPACK case is not damaged and operates after each and all drops. Test method: MIL-STD-810D, Method 516.3, Procedure IV.

Loose Cargo. TRIMPACK withstands a combination of vibration and shock as would be encountered during loose shipment on an open truck bed. The TRIMPACK is exposed to 1 inch, double amplitude 5 Hertz vibration while being loosely contained in a wood box. TRIMPACK is tested 30 minutes on each of six faces. The TRIMPACK operates after test. Test method: MIL-STD-810D, Method 514.3, Procedure II.

Sand. TRIMPACK satisfies the performance requirements of this specification when exposed to sand and windblown sand. The TRIMPACK and the remote antenna/preamplifier are completely sealed units. Test method: MIL-STD-810D, Method 510.2, Procedure II.

CAUTION

The display window is made of polycarbonate, a plastic. This window is not affected by the sand test. However, caution should be used in cleaning abrasive debris from this surface. The surface can be scarred which could impair display readability.

Fungus. TRIMPACK is designed to the maximum extent possible using non-nutrient materials. Fungus testing is not conducted.

Salt Atmosphere. TRIMPACK withstands exposure to salt fog in both an operating and non-operating condition. The TRIMPACK shows no evidence of corrosion or degradation in performance after exposure to salt fog, for 96 hours with a 5% salt solution. Test method: MIL-STD-810D, Method 509.2, Procedure I.

Immersion. The TRIMPACK is watertight and shows no signs of moisture intrusion after being submerged for 2 hours to a depth of 2 meters of water. Test method: MIL-STD-810D, Method 512.2, Procedure 1.

Rain. Since the TRIMPACK will operate submerged in water, the rain test is not performed. Care was taken in the case design to preclude surfaces which will pond or entrap water and impair the use of TRIMPACK. When the battery compartment is open, the electronic compartment is still sealed. The battery compartment seal is also tested by immersion to 2 meters.

Orientation. The TRIMPACK performance is not degraded as a result of its physical orientation. Satellite visibility to the antenna is necessary during this test when operating on the internal antenna.

6.3 Electromagnetic Emission and Susceptibility

TRIMPACK is designed to meet FCC regulations and the requirements of MIL-STD-461 when used with a vehicle power filter. Emissions and susceptibility requirements for Class A1a, Air Force and Navy, were tested in accordance with the procedures in MIL-STD-462. See EMTR-92302 for a complete description of tests and results. For the applicability of a particular EMI environment, contact Trimble Navigation.

6.4 Reliability

Reliability is calculated to be 17,300 hours (MTBF) for the 3-Channel TRIMPACK, excluding batteries, per MIL-HDBK-217E.

Reliable Operating Life. The design life expectancy for the TRIMPACK is 15 years under any combination of operational conditions and environmental conditions specified in this document. This requires replacement of the internal back-up battery at approximately 5 year intervals. The battery pack to TRIMPACK body o-ring seal also requires replacement when wear from entrapped debris prevents proper sealing.

6.5 Maintainability

The maintenance concept for TRIMPACK is that all repairs be completed at the depot level. There is no scheduled maintenance at the operation level.

O or Operator Level. The operator level is restricted to changing the prime power batteries and keeping the exterior of the case clean.

Although protected when assembled, the latch and the retaining bracket for the battery pack are designed to be replaceable in the field without special tools. If accidentally broken these parts can be replaced within less than 5 minutes. Spare bails and clips will be available. If wear dictates, the battery compartment o-ring seal is field replaceable.

D or Depot Level. Defined for TRIMPACK as Trimble or Trimble's European, Far Eastern, or Middle Eastern repair facilities. When returned to these facilities, any type of repair is feasible. The planned repair cycle is an average of 1.5 hours per unit with a maximum repair time of 3.0 hours. This maintenance includes the removal and replacement of piece parts. Failure is localized, isolated, disassembled, replaced, tested, re-assembled and system tested. Prior to return to a customer each TRIMPACK is tested using a simulator or satellites. If a critical part is replaced, such as an oscillator, the TRIMPACK may be subjected to a burn-in cycle. This added process is at Trimble's option and will extend time to complete maintenance.

Mean Time to Repair (MTTR). At O Level the mean time to change a TRIMPACK battery is 5 minutes. At D level the mean time to repair is 1.5 hours assuming no burn-in cycle.

Periodic Maintenance. TRIMPACK does not require scheduled maintenance. Replacement of the RAM holdup battery once in 5 to 7 years is the only exception to this statement.

Storage Life. The TRIMPACK meets all requirements of this specification without component replacements, adjustment, or maintenance. The RAM holdup battery, after being in storage for a period of five to ten years at temperatures between -55° and +85°C, may require replacement. The TRIMPACK will operate but the functions/modes requiring retention of data in memory will be impaired. The TRIMPACK will operate similar to first power on after each power off. Replacement of the memory battery will make the TRIMPACK fully functional.

6.6 Materials, Processes and Parts

A combination of commercial, industrial and military parts are used in TRIMPACK. Processes are controlled, modified and adjusted commercial processes which provide a product with high reliability and maximized quality repeatability.

6.7 Design and Construction

Design and construction is based on guidance from MIL-E-5400, MIL-E-16400 and MIL-STD-454. The highest quality of commercial design practice has been used in the development of this product. Military specifications, standards and handbooks are used as design guidance to ruggedize the TRIMPACK.

6.8 Workmanship

TRIMPACK is fabricated in accordance with MIL-STD-454 requirements for soldering fasteners and hardware, terminals, resistance welded electrical interconnection, brazing, internal wiring practices and general workmanship. All other workmanship is in accordance with the best commercial standards for this type of product.

6.9 Safety

TRIMPACK has been designed to satisfy the safety requirements of MIL-STD-454, Requirement 1. The design incorporates mechanical and electrical safety standards both when the TRIMPACK is operable and when in maintenance status.

WARNING

Lithium batteries can be a safety hazard. The handling procedures set out by the various battery manufacturers must be carefully adhered to. Each battery is protected from short circuit by an internal, inaccessible fuse. Once this fuse has blown, a battery is unusable.

Discharged batteries are also a safety hazard if subjected to temperatures above 125°C or severe shock.

The TRIMPACK case is conductive similar to a metal case. Do not allow the case to contact a voltage source which can cause electrical shock.

6.10 Interchangeability

TRIMPACK hardware replaceable modules, chassis components and equipment mounts are interchangeable with like items from another TRIMPACK without adjustment or alignment. Matched/mated replaceable modules are not required in order to achieve specified performance.

6.11 Calibration

The TRIMPACK was designed so as to preclude the need for any calibration. During manufacture the crystal oscillator is adjusted to center frequency. Crystal aging was considered in design for the 15 year life, but is not 100% predictable. Experience may prove a very small percentage of the sets may have to be adjusted after about 10 years' use.

6.12 Identification and Marking

Markings were guided by the requirements of MIL-STD-454, Requirement 67, MIL-STD-129 and MIL-STD-130. External marking can be modified to satisfy customer needs, both on the product and the materials used for packaging and shipment.

6.13 Testability

TRIMPACK hardware is designed for automatic testing to be used in both manufacture and maintenance. Access to the digital communication channel via an external test connector permits automatic functional test of the complete system.

Built-in test allows the operator to isolate faults among the TRIMPACK, remote antenna, or operation of the external digital interface. A maintenance person can access data which contains specific voltages, signal strengths, temperature and fault indications. See System Test procedure, Section 7.2.

6.14 Human Performance/Human Engineering

The TRIMPACK is simple to operate and was designed to minimize the number and type of operator actions required to request an output. The TRIMPACK controls are operable while wearing cold weather gear, including arctic mittens. Displays are comfortably readable with the naked eye under ambient light conditions from sunlight to total darkness. Displays provide data in easily understandable and interpretable formats and respond to all operator requests within one second.

7.0 INSTALLATION SPECIFICATIONS AND INSTRUCTIONS

7.1 Installation Procedures

The size, weight and physical design of the TRIMPACK allows uncomplicated installation and check-out in most host vehicles. This section describes the installation of TRIMPACK and gives the integrator the critical dimensions, the mechanical and electrical interface and specifies those conditions proven necessary by experience or design.

7.1.1 Mechanical Installation

Vibration and Shock Environment. The mechanical installation of the TRIMPACK is governed by the shock and vibration environment in which it is to be installed. If the vibration environment is equal to or less than the shock and vibration profile described in section 6.2 of this specification, the TRIMPACK can be hard mounted. If the environment exceeds this, isolators are required. A drawing is provided showing a typical hard mounting structure in Appendix B. This mount provides the capability to mount the TRIMPACK from above or below and can be tilted or rotated to optimize the viewing angle. The rotation angle is user selectable whereas tilt requires a wrench for adjustment.

CAUTION

Vibration and shock isolation must be designed for a specific structure, mass to be isolated and forcing function. The shock loading due to crash, gun fire and the like must be addressed not only to protect the equipment but also to make certain the mount will remain intact under the worst shock loading anticipated. A minimum factor of safety of 3.0 is suggested for aircraft installation and 5.0 if weight is not a consideration.

Each mounting location must be analyzed and a specific design developed for the location which considers the environment, the space and the supporting structure.

Remote Antenna Cable Installation. Stress relief should be provided on the antenna feedline. If the TRIMPACK is vibration isolated, adequate slack must be allowed in the cabling to account for movement in the soft mounts as well as for adjustments for viewing angle. If custom cable is field fabricated, a VSWR of less than 2.0 is required so care must be exercised in selecting angle and bulkhead connectors. The center conductor of the coaxial cable carries the power to the preamplifier so its round-trip DC resistance must be less than 1 ohm DC.

External Antenna/Preamplifier Location and Fastening. Select a location for the antenna so that satellite visibility is maximized during all types of vehicle movement. Since 10 dB of attenuation is the maximum amount allowable between the antenna and TRIMPACK, the distance between the units will govern the type of coaxial cable used. Depending on this selection of cable bend radii and cable pulling clearances can be accounted for in the routing.

The fastening of the antenna/preamplifier unit to the host vehicle is accomplished with machine screws through four holes in the antenna radome casting. The surface to which the antenna mounts must be flat to 0.02 inch so as to preclude warping of the antenna during installation.

Either the supplied gasket or commercially available conductive caulking material should be used to seal the antenna to the vehicle while maintaining electrical contact between the antenna and a metallic surface on which it is mounted.

The preamplifier casing is fabricated from aluminum alloy. The exposed surface has been chemically treated with an alodine coating to prevent corrosion while still being conductive. This surface is fragile and should be protected from rough handling during installation.

External Power Cable. Two different cable assemblies are available to provide external power. The first is used where EMI and EMC requirements are governed by FAA and FCC regulations. The second assembly attaches to the Vehicle Power Adapter (VPA) for use where high ambient RF radiation exists and MIL-STD-461 requirements must be met.

The mechanical connection to the TRIMPACK for both of these cables is through the external power unit U229/UG2 connector.

The cable that meets FAA and FCC requirements is 2 meters in length and contains replaceable fuses in the supply and return lines. During installation, access to these fuses must be assured. Connection to the host power source is through spade lugs. Standard installation practices should be used on this assembly.

The cable assembly which meets full MIL-STD-461 requirements connects to the VPA. This cable is symmetrical so either connector can be attached to the TRIMPACK or the VPA. It is a fully shielded cable so bend radii and mechanical stress are important.

Vehicle Power Adapter. The VPA must be mounted to the major grounded structure of the vehicle so as to provide a good ground at high frequencies. Since the Vehicle Power Adapter contains a fuse it must be placed in a location where this fuse is accessible.

The mechanical mounting of the VPA is by four fasteners through the corners of the bottom flange.

Data I/O Cable. There are no special requirements for the mechanical installation of this cable. Standard practice shall be used.

The digital connector, GC-283-15, is a bulkhead circular audio mounting connector. It is watertight to 2 meters if the mating connector is installed. The mating connector is a GC-329 solder cup 6-pin connector. Backshells and strain relief are readily available and should be selected depending on the RF environment in which the TRIMPACK will be installed.

7.1.2 Electrical Installation

Digital Interface Electrical Details and Software Protocol. The electrical details of the digital interface are provided by the standard specification for the RS-422 bus structure. The software and protocol information is provided in Appendix A of this document.

External Power. TRIMPACK can be powered through the 5-pin connector on the left panel of the TRIMPACK housing. The mate to the power connector is a GC-329U solder cup. TRIMPACK will operate on steady state voltage between 9 and 32 Volts DC.

The allowable distortion factor, defined as the ratio of the DC distortion to the average DC voltage, is 0.04, maximum. (Distortion is the RMS of the superimposed alternating voltage.) The maximum ripple amplitude is 1.5 Volts. The allowable voltage transients are 50 Volts for a duration of 50 microseconds to 50 milliseconds.

The Vehicle Power Adapter is placed between the TRIMPACK and vehicle power source. This unit electrically filters the input power and should be placed as close to the power source as possible. The bonding resistance between the Vehicle Power Adapter and the mounting structure should be less than 0.5 ohms. With this unit installed as specified herein, the requirements of MIL-STD-461 are met.

7.2 System Test Procedure

Operational Test. Once powered, TRIMPACK will execute satellite search algorithms and, ultimately, provide the position, velocity, and time solutions. To ensure proper operation, TRIMPACK has the capability to execute self-test processes and also provide continuous monitoring of key operational parameters. The information provided by these methods allows the user to identify failure of particular sections of the system operation. The system failure messages and diagnostic data are available over the digital communication channel. Appendix A provides a detailed description of the data packet identifications, formats and codes enabling the self-test information to be processed.

To receive and process the digital information being sent by the TRIMPACK, a computer and software are required. This software may be generated by the user specifically for the user's interfacing equipment. The system error and diagnostic information is summarized in Table 7-1. The information is sent in the form of toggled bits at particular BYTE positions as described in Appendix A. TRIMPACK will output such information in response to three events: 1) in response to the appropriately identified inquiries by the user, 2) whenever there is a change in error status, and 3) at power-up when self-test is initiated. The TRIMPACK will also display an error code on the STS screen.

Table 7-1. TRIMPACK ERROR and STATUS DIAGNOSTICS
(Fault isolation from data channel)

Error Code	Description	Fault	Assembly
01	Battery Back-up Failed	Back-up Battery	Digital Board (or Memory Erase function)
02	Signal Processor Error	Custom IC	Digital Board
04	Alignment Error, Channel 1	Custom IC	Digital Board
08	Alignment Error, Channel 2	Custom IC	Digital Board
16	Antenna Feedline Fault	Cable Short/Open	Antenna Cable/Analog
32	Excessive Bias Dot	Oscillator	Analog Board
64	Synthesizer Fault	L.O./P.L.L. Chain	Analog Board
128	Battery Powered Clock Fault	Real Time Clock	Digital Board
256	A-to-D Converter Fault	A-to-D Converter	Analog Board

The TRIMPACK continuously monitors several operating parameters that have undergone analog-to-digital conversion and are available for output. This set of data is sent in response to requests via the digital interface. Table 7-2 is a summary of the parameters and the range of values expected during normal operation.

Table 7-2. Diagnostic Parameters Available at Data Port

Parameter	Normal Range	Subsystem
Temperature (C)	<10°C above ambient	---
Display Temperature	<10°C above ambient	---
Synth Control Volt	0.25 - 4.5	Synthesizer
IF Signal Level	0.5 - 2.0	RF chain
External Antenna Voltage	3.5 - 5.1	Antenna/Interface
Internal Antenna Voltage	less than 0.2V or 4.7 - 5.1V	
Primary Power	less than 0.2V for external power or internal battery voltage divided by 3.56	

7.3 Troubleshooting

Self-test and diagnostic information provided on the digital communication channel can provide fault isolation. In the paragraphs below, this information is reviewed along with additional troubleshooting procedures. The failure message or symptom is identified along with the probable cause of the failure and recommendation for possible repair or replacement.

"Battery Back-up Failed" code on digital channel.

Problem Origin: Battery has been shorted, memory cleared, or ROMs replaced.

Recommendation: The failure of the battery backup causes loss of stored parameters, time, almanac, etc. It must be determined whether the battery is shorted externally or it has failed. The battery can be visually inspected on the Digital Board to ensure that the leads are clear of foreign contact. Measured battery voltage should be greater than 3V. If the battery has been temporarily shorted, the memory has lost its stored information but is still operational. Power the receiver and allow the TRIMPACK to collect time and almanac information from satellites. After power-off, the battery should hold this information. The next power-on will alert the user if the battery-backed memory has failed to hold the information. The Digital Board can be replaced or sent to Trimble for replacement of the battery. If the memory has been cleared, this error code will persist until the TRIMPACK is power cycled.

"Signal Processor Error" code on digital output.

Problem Origin: Signal Processor, Custom IC or processor timing.

Recommendation: Replace the Digital Board.

"Alignment Error, Channel 1 (or 2)" code.

Problem Origin: Custom IC failure

Recommendation: Replace the Digital Board.

"Antenna Feedline Fault" code on digital output.

Problem Origin: Antenna interface not complete or antenna failure.

Recommendation: Check to make sure that the antenna cable connections are secure at the antenna and the TRIMPACK. If connected properly and the problem persists, replace the antenna feedline cable.

"**Excessive Bias Dot**" code on digital output.

Problem Origin: Oscillator frequency offset is too large.

Recommendation: Replace the Analog Board.

"**Synthesizer Fault**" code on digital output.

Problem Origin: Improper operation of synthesizer.

Recommendation: Replace the Analog Board.

"**Battery Powered Time Clock Fault**" code on output.

Problem Origin: Real time clock or battery has failed.

Recommendation: Replace the Digital Board.

"**A-to-D Converter Fault**" on digital output.

Problem Origin: Failure of analog to digital converter.

Recommendation: Replace the Analog Board.

IF Signal Level out of specified range. (A-to-D)

Problem Origin: Problem in RF analog circuits.

Recommendation: Replace the Analog Board.

Antenna voltage out of specified range. (A-to-D)

Problem Origin: Antenna or antenna interface problem.

Recommendation: Check antenna cable connections and the antenna cable itself.

Primary Power out of specified range. (A-to-D)

Problem Origin: Power supply providing improper TRIMPACK voltage.

Recommendation: If the prime power reads more than 0.2V when using external power, the the battery life timer will not function properly and the power supply board should be checked.

No digital signal output over communication channel.

Problem Origin: Nav processor or I/O hardware

Recommendation: Replace the Analog Board and/or Digital Board.

Trimble Navigation Service and Replacement Parts. Trimble Navigation provides service of TRIMPACK equipment in accordance with the product warranty. The preceding maintenance, repair, and troubleshooting sections of this manual provide the ability to isolate failures to the line replaceable unit (i.e., TRIMPACK, antenna cable, antenna/preamplifier). TRIMPACK failures can be further isolated to the board level. Should a failure of a particular line replaceable item occur, Trimble Navigation recommends that the user contact Trimble Navigation and arrange for the TRIMPACK to be returned for service, compliant with the warranty. Although this document has provided procedures and diagnostic interpretation for probable fault isolation to the board level of the TRIMPACK, returning the entire TRIMPACK to Trimble Service is suggested for complete diagnosis. If required, part replacement at the board level can be accomplished through Trimble Navigation Service. The TRIMPACK board subassembly descriptions in this document provide the board level part numbers necessary for this process.

7.4 TRIMPACK Accessories and Optional Assemblies

TRIMPACK was designed primarily as a stand-alone navigation system but has various accessories which allow its installation in ground and air vehicles, operation off external power and interface with data reading systems or computers for the display of maintenance data and diagnostics.

To support these uses and/or installations, the accessories shown in Table 7-3 are available.

Table 7-3. Optional Accessories

Part Number	Part Name	Function
16768-00	TRIMPACK	The basic navigation system with red screen.
16768-10	TRIMPACK	Basic with Have Quick (green screen).
16768-20	TRIMPACK	Basic with green screen.
16768-30	TRIMPACK	Basic with 1089 waypoints
12038-00	Antenna/preamplifier	Remoteable antenna with built-in preamplifier
12765-00	Antenna Cable	6 meter RF cable from antenna to TRIMPACK (SMA to SMA)
12960-00	Antenna with Platform Mount	Flush mounting structure for antenna with N type connector
13229	SMA to N Adapter	
12920-00	Magnetic Mount for Antenna	Mount for attachment to ferrous metal vehicles
12793-00	Data Cable RS-422	TRIMPACK to I/O
13826-00	Data Cable	TRIMPACK to TRIMPACK data cable
12792-00	Power Cable	External power cable fused non-filtered
13825-00	Vehicle Power Adapter Assy	Power conditioning unit assembly, which includes the following two cables:
13830-00	Power Cable	TRIMPACK to vehicle power adapter
13849-00	Power Cable	Vehicle Power Adapter to power source (spade lug)
13827-00	Battery Pack	Double BA5800 or double 6800 battery pack
13828-00	Battery Pack	Single BA6800 battery pack
13829-00	Battery Pack	NiCad rechargeable battery pack
12549	Antenna Gasket	Conductive gasket for mounting

APPENDIX A

TRIMPACK GPS RECEIVER

DIGITAL COMMUNICATIONS INTERFACE DEFINITION

P/N 13498, Rev. D
November 1990

Trimble Navigation Ltd.
Sunnyvale, CA 94086

TRIMPACK GPS RECEIVER
DIGITAL COMMUNICATION INTERFACE DEFINITION

1.0 INTERFACE SCOPE

This section defines the digital communication interfaces for the TRIMPACK GPS receiver. The digital output channel is available on an external communication port on the receiver.

This channel has a protocol based on the transmission of packets of information passed between the user and the TRIMPACK. These packets are preceded with identification codes (1 Byte, hex) that identify the format of the floating point data that follows. The entire packet is delimited by control characters.

This section describes in detail the format of the data transmitted and the code identifiers. All available information over this channel is described, giving the user the flexibility to choose the data required for the particular application. As will be discussed, some of the information (position and velocity solutions, etc.) will automatically be transmitted when available. Other information will be output only on request.

2.0 APPLICABLE ELEMENTS

2.1 Applicable Hardware Components

TRIMPACK GPS Receiver (P/N 16768-XX)

2.2 Applicable Documents

The issue of each document which existed on 1 July 1988 is the issue to be used.

SS-GPS-300B	System Specification for the NAVSTAR Global Positioning System
ICD-GPS-200	NAVSTAR GPS Space Segment/Navigation User Interfaces

3.0 SIGNAL CHARACTERISTICS

3.1 General

The user interface signals are EIA RS-422 balanced conductor pairs. For the short line lengths anticipated, the user's receive-end need not be terminated. The format is standard serial, sent least-significant-bit first, at 9,600 baud, with 8 data bits, odd parity, and one stop-bit. For details, see Section 3.6 of the manual, *Digital Communication Interface*.

3.2 Packet Data Format

Each packet type is described below. Where necessary, specific data formats are given.

The **INTEGER** data type is a 16-bit signed number sent in 2s-complement format, most significant byte first.

A floating-point number, sometimes called "scientific notation" (for decimal numbers), or a **REAL** number, consists of a signed mantissa and a signed exponent. The precision is determined by the number of digits in the mantissa, and the range of expressible values is determined by the number of digits in the exponent. In a non-zero binary floating-point number, the mantissa consists of a "1," followed by the binary point, followed by the fractional part of the mantissa. Note that the leading binary "1" is redundant.

For floating-point numbers, the TRIMPACK uses the ANSI/IEEE Std 754 *IEEE Standard for Binary Floating-Point Arithmetic*, in which the formatted exponent is biased to avoid the use of an exponent sign, the mantissa's redundant leading "1" is omitted, and various special cases are specified. The IEEE 754 standard specifies two degrees of precision, "SINGLE" and "DOUBLE," both of which are used in the TRIMPACK. The DOUBLE-precision format uses more bits both in the mantissa (for greater precision) and in the exponent (for greater range). The IEEE 754 format is described briefly below.

> The sign-bit is 1 for a negative number and is 0 for a positive number.
>
> To ensure that the formatted exponent is non-negative, and thus to avoid the use of an exponent sign, the formatted exponent (the *biased exponent*) is the sum of the actual (signed, unbiased) exponent plus a constant (the bias).
>
> The redundant leading "1" is not included; only the fractional part of the mantissa is included and is called the "fraction."
>
> The value *zero* is formatted by setting both the biased exponent and the fraction to zero. Note that this special case must be recognized as zero and not interpreted as described above for a non-zero number.
>
> The IEEE 754 standard specifies various other special cases. For programming and for detailed data analysis, the user should consult the IEEE standard.

The TRIMPACK "SINGLE" data type is a 32-bit (4-byte) single-precision floating-point number in the ANSI/IEEE Std 754 SINGLE (short) format. The first byte sent contains the sign-bit of the mantissa and the 7 most-significant bits of the biased exponent. The second byte contains the least-significant bit of the biased exponent, followed by the 7 most-significant bits of the fraction (the part of the mantissa to the right of the binary point). The remaining 2 bytes complete the fraction. The exponent bias is +127; i.e., the biased exponent is the actual exponent +127. With the implied (unformatted) leading "1," the single-precision mantissa contains 24 significant bits.

The TRIMPACK "DOUBLE" data type is a 64-bit (8-byte) double-precision floating-point number in the ANSI/IEEE Std 754 DOUBLE (long) format. The first byte sent contains the sign-bit of the mantissa and the 7 most-significant bits of the biased exponent. The second byte contains the 4 least-significant bits of the biased exponent, followed by the 4 most-significant bits of the fraction. The remaining 6 bytes complete the fraction. The exponent bias is +1,023. With the implied (unformatted) leading "1," the double-precision mantissa contains 52 significant bits.

3.3 Packet Structure

In both directions of information transmission, the data format conforms to a packet structure as follows. Each packet starts with the two-character sequence.

<DLE> the ASCII "data link escape" character, 1 byte, value 10 hex

<id> the packet type identification number, 1 byte, expressed as 2 hexadecimal digits. This byte can have any value other than 10 hex (ASCII <DLE>) or 03 hex (ASCII <ETX>). The values and their meanings are given in the remainder of this appendix.

Each packet ends with the two-character sequence.

<DLE> the ASCII "data link escape" character, 1 byte, value 10 hex

<ETX> the ASCII "end-of-text" character, 1 byte, value 03 hex.

The packet format is shown below.

```
-------------------------------------------------------------------------
<DLE>  <id>  ... data bytes ...  <DLE>  <ETX>
-------------------------------------------------------------------------
```

Each packet data byte can have any 8-bit value, with the one requirement that any data byte of value 10 hex (<DLE>) must be sent twice. The receiving devices (in both the TRIMPACK and the user's data terminal) must compress all occurrences of two <DLE> characters into one <DLE> data byte. The data portion of the packet may be from 0 to 255 bytes long, not counting <DLE> stuffing.

3.3.1 Packets Sent By The User To The TRIMPACK

The table below provides the packet ID numbers sent by the user to the TRIMPACK, a short description of each packet, and the identities of the packets which the TRIMPACK sends in response. In some cases, the response packets depend on user-selected options. These selections are covered in the packet descriptions below. Details are provided for each packet type in the following sections.

Packets Sent By The User To The TRIMPACK

<id> (hex)	Description	Response Packet Sent By TRIMPACK
1D	clear oscillator offset	--
1E	clear battery back-up, then reset	--
1F	request software versions	45
20	request almanac	40
21	request current time	41
22	mode select (2-D, 3-D, auto)	--
23	initial position (XYZ ECEF)	--
24	request TRIMPACK position fix mode	44
25	initiate soft reset & self-test (equivalent to cycling power)	45, 46, 4B, 42 or 83 or 4A or 84
26	request health	46, 4B
27	request signal levels	47
28	request GPS system message	48
29	request almanac health page	49
2A	altitude for 2-D mode	--
2B	initial position (Lat, Lon, Alt)	--
2C	set/request operating parameters	4C
2D	request oscillator offset	4D
2E	set GPS time	4E
31	accurate initial position (XYZ Cartesian ECEF)	--
32	accurate initial position (lat, lon, alt)	--
33	request A-to-D readings	53
34	satellite number for 1-sat mode	--
35	set/request I/O options	55
36	velocity aiding of acquisition	--
37	request status and values of last pos & vel	57; 42 or 83 or 4A or 84; 43 or 56
38	request/load satellite system data	58
39	set/request satellite disable or ignore health	59
3A	request last raw measurement	5A
3B	request satellite ephemeris status	5B
3C	request tracking status	5C
90	load waypoint into TRIMPACK	92/93
91	request a waypoint from TRIMPACK	90
99	load set-up parameters	92/93
9A	request set-up parameters from TRIMPACK	99

3.3.1.1 1D Clear Oscillator Offset

This packet commands the TRIMPACK to clear the oscillator offset stored in battery-backed memory. This packet contains one data byte equal to the ASCII letter "C," 43 hex. Note that packet 2D hex can be used to request the current value of the offset; this information is used mainly for service. In normal use, there is no need to send this packet.

3.3.1.2 1E Clear Battery Back-up, then Reset

This packet commands the TRIMPACK to clear all battery back-up data and to perform a software reset. This packet contains one data byte equal to the ASCII letter "K," 4B hex.

CAUTION

All almanac, ephemeris, current position, mode, and calibration, information is lost by the execution of this command. In normal use this packet should not be sent.

3.3.1.3 1F Request Software Versions

This packet requests information about the version of software running in the Navigation and Signal Processors. This packet contains no data bytes. The TRIMPACK returns packet 45 hex.

3.3.1.4 20 Request Almanac

This packet requests almanac data for one satellite from the TRIMPACK. This packet contains one data byte specifying the satellite PRN number. The TRIMPACK returns packet 40 hex.

3.3.1.5 21 Request Current Time

This packet requests current GPS time. This packet contains no data. The TRIMPACK returns packet 41 hex.

3.3.1.6 22 Position Fix Mode Select

This packet commands the TRIMPACK to operate in a specific position fix mode. This packet contains one data byte indicating the mode, as follows:

Mode	Data byte value
Automatic	0 (default value)
1-satellite (0-D)	1
3-satellite (2-D)	3
4-satellite (3-D)	4

This selection is held in battery-backed memory

The 1-satellite (0-D) mode uses a single satellite to determine receiver clock error (time) and error rate (frequency) when the position is known precisely. In this mode, the TRIMPACK computes no positions or velocities. Instead, the TRIMPACK sends packet 54 hex with the clock bias and bias rate. This can be used for time transfer applications and to enable the TRIMPACK to maintain the accuracy of the one PPS (Pulse Per Second) output even if a full position fix cannot be done.

3.3.1.7 **23** Initial Position (XYZ Cartesian ECEF)

This packet provides the TRIMPACK with an approximate initial position in Cartesian ECEF (Earth Centered, Earth Fixed) WGS-84 coordinates. This packet causes a world-wide search for the user's position, starting at the position entered via this packet. That takes about 6 to 10 seconds before the TRIMPACK can provide more fixes. This packet is useful if the user has moved more than about 1,000 miles after the previous fix. (Note that the TRIMPACK can initialize itself without any data from the user; this packet merely reduces the time required for initialization.) This packet does not cause a software reset.

The data format is shown below. The X-axis points toward the intersection of the equator and the Greenwich meridian, the Y-axis points toward the intersection of the equator and the 90° meridian, and the Z-axis points toward the North Pole.

Byte #	Item	Type	Units
0-3	X	SINGLE	meters
4-7	Y	SINGLE	meters
8-11	Z	SINGLE	meters

3.3.1.8 **24** Request TRIMPACK Position Fix Mode

This packet requests current position fix mode of the TRIMPACK. This packet contains no data. The TRIMPACK returns packet 44 hex.

3.3.1.9 **25** Initiate Soft Reset & Self Test

This packet commands the TRIMPACK to perform a software reset. This is equivalent to cycling the power. The TRIMPACK performs a self-test as part of the reset operation. This packet contains no data. The TRIMPACK returns packets 41, 45, 46, 4B, (42 and 4A) or (83 and 84), all hex. The TRIMPACK sends packet 45 hex only on power-up and reset (or on request); thus if packet 45 appears unrequested, then either the TRIMPACK power was cycled or the TRIMPACK was reset.

3.3.1.10 **26** Request Health

This packet requests health and status information from the TRIMPACK. This packet contains no data. The TRIMPACK returns packet 46 hex and 4B hex.

3.3.1.11 **27** Request Signal Levels

This packet requests signal levels for all satellites currently being tracked. This packet contains no data. The TRIMPACK returns packet 47 hex.

3.3.1.12 **28** Request GPS System Message

This packet requests the GPS system ASCII message sent with the navigation data by each satellite. This packet contains no data. The TRIMPACK returns packet 48 hex.

3.3.1.13 **29** Request Almanac Health Page

This packet requests the TRIMPACK to send the health page from the almanac. This packet contains no data. The TRIMPACK returns packet 49 hex.

3.3.1.14 **2A** Altitude for 2-D Mode

This packet provides the altitude to be used for Manual 2-dimensional (3 satellite) mode. This altitude is used for Auto 2-D mode until a 3-D fix is performed. This packet contains one SINGLE number (4 bytes) specifying the altitude in meters, using the WGS-84 model of the earth or MSL geoid altitude depending on I/O options (set by packet 35). This altitude value is held in battery-backed memory.

3.3.1.15 **2B** Initial Position (Latitude, Longitude, Altitude)

This packet provides the TRIMPACK with an approximate initial position in latitude and longitude coordinates (WGS-84). This packet causes a world-wide search for the user's position, starting at the position entered via this packet. That takes about 6 to 10 seconds before the TRIMPACK can provide more fixes. This packet is useful if the user has moved more than about 1,000 miles after the previous fix. (Note that the TRIMPACK can initialize itself without any data from the user; it merely requires more time.) This packet does not cause a software reset.

The data format is shown below.

Byte #	Item	Type	Units
0-3	latitude	SINGLE	radians, north
4-7	longitude	SINGLE	radians, east
8-11	altitude	SINGLE	meters

3.3.1.16 2C Set/Request Operating Parameters

This packet optionally sets the operating parameters of the TRIMPACK receiver and requests the current values after setting them. The data format is shown below. The TRIMPACK returns packet 4C hex.

The dynamics code indicates the expected vehicle dynamics and is used to assist the initial solution.

The elevation angle mask determines the lowest angle at which the TRIMPACK tries to track a satellite.

The signal level mask sets the required signal level for a satellite to be used for position fixes.

The PDOP mask sets the maximum PDOP with which position fixes are calculated. The PDOP switch selects the 2-D and 3-D mode. If 4 or more satellites are available and the resulting PDOP is not greater than the PDOP switch value, then 3-dimensional fixes are calculated. The PDOP switch is effective only in the automatic 2-D/3-D mode.

Byte #	Item	Type	Units	Default value
0	Dynamics code BYTE			
	Value	**Meaning**	**Assumed velocity**	
	0	Current value is left unchanged.		
	1	land	< 120 knots	
	2	sea	< 50 knots	
	3	air (default)	< 600 knots	
	4	static	stationary	
1-4	Elevation angle mask	SINGLE	radians	0.1745 (10^{o})
5-8	Signal level mask	SINGLE	---	6
9-12	PDOP mask	SINGLE	---	12
13-16	PDOP switch (3-D or 2-D)	SINGLE	---	8

A negative value in a SINGLE field leaves that current setting unchanged.

This information is held in battery-backed memory.

Mode 4 selection informs the TRIMPACK that it is stationary. Any position fix computed or provided via the data channels is assumed to be accurate indefinitely. When the dynamics code is set to static (byte value = 4) and the fix mode is automatic (set by packet 22 hex), then the TRIMPACK enters automatic 1-satellite mode when a position fix cannot be performed but there is at least one usable satellite. In this mode, no positions or velocities are computed. Instead, the TRIMPACK sends packet 54 hex with the clock bias and bias rate. As long as the TRIMPACK is truly stationary, this mode can be used for time transfer applications and to enable the TRIMPACK to maintain the accuracy of the one PPS (Pulse Per Second) output even if a full position fix cannot be done.

3.3.1.17 **2D** Request Oscillator Offset

This packet requests the calculated offset of the TRIMPACK master oscillator. This packet contains no data. The TRIMPACK returns packet 4D hex. This packet is used mainly for service. The permissible oscillator offset varies with the particular TRIMPACK unit.

3.3.1.18 **2E** Set GPS Time

This packet provides the approximate GPS time of week and the week number to the TRIMPACK. The TRIMPACK returns packet 4E hex. The data format is shown below. The GPS week number reference is Week # 0 starting January 6, 1980. The seconds count begins at the midnight which begins each Sunday morning.

Byte #	Item	Type	Units
0-3	GPS time of week	SINGLE	seconds
4-5	GPS week number	INTEGER	weeks

This packet normally is not needed as the internal battery-powered clock keeps time to sufficient accuracy for finding position rapidly.

3.3.1.19 **31** Accurate Initial Position (XYZ Cartesian ECEF)

This packet is identical in content to packet 23 hex. This packet provides an initial position to the TRIMPACK in XYZ coordinates. However, the TRIMPACK assumes the position provided in this packet to be accurate. This packet is used for satellite acquisition aiding in systems where another source of position is available and in time transfer (one-satellite mode) applications. For acquisition aiding, the position provided by the user to the TRIMPACK in this packet should be accurate to a few kilometers. For high-accuracy time transfer, position should be accurate to a few meters.

3.3.1.20 **32** Accurate Initial Position (Latitude, Longitude, Altitude)

This packet is identical in content to packet 2B hex. This packet provides the TRIMPACK with an approximate initial position in latitude, longitude, and altitude coordinates. However, the TRIMPACK assumes the position provided in this packet to be accurate. This packet is used for satellite acquisition aiding in systems where another source of position is available and in time transfer (one-satellite mode) applications. For acquisition aiding, the position provided by the user to the TRIMPACK in this packet should be accurate to a few kilometers. For high-accuracy time transfer, position should be accurate to a few meters.

3.3.1.21 **33** Request A-to-D Readings

This packet requests the digital output of 8 monitored analog signals; response is packet 53.

3.3.1.22 **34** Satellite Number For One-Satellite Mode

This packet allows the user to control the choice of the satellite to be used for the one-satellite mode. This packet contains one byte. If the byte value is 0, the TRIMPACK chooses the usable satellite with the highest elevation above the horizon. This automatic selection of the highest satellite is the default action, and the TRIMPACK does this unless it receives this packet. If the byte value is from 1 to 32, the packet specifies the PRN number of the satellite to be used. This selection is not kept in battery-backed memory.

3.3.1.23 **35** Set/Request I/O Options

This packet requests the current I/O option states and optionally allows the I/O option states to be set as desired. To request the option states without changing them, the user sends only the packet "<DLE> (35 hex) <DLE> <ETX>" with no data bytes included. To change any option states, the user includes 4 data bytes with the values indicated below in the packet. The I/O options, their default states, and the byte values for all possible states are shown below. A glossary is given at the end of the table. These option states are held in battery-backed memory. The TRIMPACK returns packet 55 hex.

Byte #	Parameter Name	Bit Position	Default Bit Value	Option	Associated Packet
0	position	0 (LSB)	1	XYZ ECEF Output 0: off 1: on	42 or 83
		1	0	LLA Output 0: off 1: on	4A or 84
		2	0	LLA ALT Output 0: HAE WGS-84 1: MSL geoid	4A or 84
		3	0	ALT input 0: HAE WGS-84 1: MSL geoid	2A
		4	0	precision-of-position output 0: Send single-precision packet 42 and/or 4A. 1: Send double-precision packet 83 and/or 84.	
		5-7	0	unused	
1	velocity	0	1	XYZ ECEF Output 0: off 1: on	43
		1	0	ENU Output 0: off 1: on	56
		2-7	0	unused	
2	timing	0	0	time type 0: GPS time 1: UTC	
		1	0	fix computation time 0: ASAP 1: next integer sec	
		2	0	output time 0: when computed 1: only on request	37
		3-7	0	unused	
3	Auxiliary	0	0	raw measurements 0: off 1: on	5A
		1-7	0	unused	

Glossary for the table above:

ALT:	Altitude	WGS-84:	Earth model (ellipsoid)
ECEF:	Earth-centered, Earth-fixed	MSL geoid:	Earth (mean sea level) model
XYZ:	Cartesian coordinates	ENU:	east-north-up
LLA:	latitude, longitude, altitude	UTC:	coordinated universal time
HAE:	height above ellipsoid		

3.3.1.24 **36** Velocity Aiding of Acquisition

In this packet the user provides velocity information to the TRIMPACK from an external source to aid in satellite acquisition and reacquisition.

Byte	Item	Type	Units
0	Coordinate select	BYTE	

Byte Value	Meaning
0	XYZ
1	ENU (East, North, Up)

1	Velocity aiding enable flag	BYTE	

Byte Value	Meaning
0	disable velocity aiding
1	enable velocity aiding (See note below.)

2-5	X or East velocity	SINGLE	meters/second
6-9	Y or North velocity	SINGLE	meters/second
10-13	Z or Up velocity	SINGLE	meters/second

If the velocity aiding enable flag is set to "1," the TRIMPACK assumes that the velocity data is accurate to 25 meters per second or better and that it can be used for aiding. The TRIMPACK continues to use this data until another packet 36 hex is sent with the aiding enable flag set to "0" (to disable velocity aiding). Once aiding has begun, the TRIMPACK must be informed (via a new packet 36) of any velocity changes greater than 25 meters per second until velocity aiding is disabled. Once acquisition occurs, the aiding data is ignored; but if acquisition later is lost, then the aiding data is used again.

3.3.1.25 **37** Request Status and Values of Last Position and Velocity

This packet requests information about the most recent fix as well as the corresponding position and velocity. The TRIMPACK returns packet 57 and the appropriate position packet 42 or 4A, or 83 or 84, and the appropriate velocity packet 43 or 56, based on the I/O options in effect.

3.3.1.26 **38** Request/Load Satellite System Data

This packet requests current satellite data (almanac, ephemeris, etc.) or permits loading initialization data from an external source (for example, by extracting initialization data from an operating TRIMPACK unit via a data logger or computer and then using that data to initialize a second TRIMPACK unit). The TRIMPACK returns packet 58. (Note that the TRIMPACK can initialize itself without any data from the user; it merely requires more time.)

To request data without loading data, use only bytes 0 through 2; to load data, use all bytes. Before loading data, observe the caution notice below.

Byte#	Item	Type	Byte value	Meaning
0	Operation	BYTE		
			1	Request data from TRIMPACK
			2	Load data into TRIMPACK
1	Type of data	BYTE		
			1	not used
			2	Almanac
			3	Health page, T_oa, WN_oa
			4	Ionosphere
			5	UTC
			6	Ephemeris
2	Sat PRN #	BYTE		
			0	data that is not satellite-ID-specific
			1 to 32	satellite PRN number
3	length (n)	BYTE		number of bytes of data to be loaded
4 to n+3	data	n BYTES		

CAUTION

Proper structure of satellite data is critical to TRIMPACK operation. Data format, content, and protocol should be obtained through consultation with Trimble Navigation before use of this feature.

Improper data can cause the TRIMPACK software to lock up immediately after turn-on, so that the battery-backed memory cannot be cleared except by instrument service. (The TRIMPACK is not damaged physically by improper data, but it may be unusable until it is serviced.) *Requesting* **data is** *not* **dangerous;** *loading* **data improperly** *is* **dangerous. Use this packet only with extreme caution.**

3.3.1.27 **39** Set/Request Satellite Disable or Ignore Health

Normally the TRIMPACK selects satellites for use in GPS solution according to whether the candidate satellites are in good health and whether they satisfy the mask values for elevation angle, signal level, and PDOP. This packet allows the user to tell the TRIMPACK either to disable unconditionally the selection of any particular satellite or to ignore the health of any particular satellite that otherwise is acceptable for selection. The TRIMPACK returns packet 59.

Byte#	Item	Type	Byte value	Meaning
0	Operation	BYTE	1	Enable for selection (default)
			2	Disable for selection
			3	Request enable-or-disable status of all 32 satellites
			4	Heed health on satellite (default)
			5	Ignore health on satellite
			6	Request heed-or-ignore status on all 32 satellites
1	Satellite #	BYTE	0	all 32 satellites
			1 to 32	any one satellite PRN number

This information is not held in battery-backed memory. At power-on and after a reset the default values are set for all satellites.

CAUTION

Improperly ignoring health can cause the TRIMPACK software to lock up, as an unhealthy satellite may contain defective data. Generally, such software lock-up is clearable by the TRIMPACK user, although improper data can cause the TRIMPACK software to lock up immediately after turn-on, so that the battery-backed memory cannot be cleared except by instrument service. (The TRIMPACK is not damaged physically by this, but it may be unusable until it is serviced.) Use extreme caution in ignoring satellite health.

3.3.1.28 **3A** Request Last Raw Measurement

This packet requests the most recent raw measurement data for one specified satellite. The TRIMPACK returns packet 5A hex.

Byte#	Item	Type	Byte value	Meaning
0	Satellite #	BYTE	0	All satellites in the current tracking set
			1-32	Desired satellite

3.3.1.29 **3B** Request Current Status Of Satellite Ephemeris Data

This packet requests the current status of satellite ephemeris data. The TRIMPACK returns packet 5 B hex.

Byte#	Item	Type	Byte value	Meaning
0	Satellite #	BYTE	0	All satellites in the current tracking set
			1-32	Desired satellite

3.3.1.30 **3C** Request Current Satellite Tracking Status

This packet requests the current satellite tracking status. The TRIMPACK returns packet 5C hex.

Byte#	Item	Type	Byte value	Meaning
0	Satellite #	BYTE	0	All satellites in the current tracking set
			1-32	Desired satellite

3.3.1.31 **90** Load Waypoint into TRIMPACK

Sends waypoint data into or from the TRIMPACK. Response is a positive acknowledge, packet 92, or a negative acknowledge, packet 93.

Byte#	Item	Type	Units
0-1	Waypoint Number (0-25)	INTEGER	---
2-13	User label field	ASCII	---
14-37	X,Y,Z (WGS-84) coordinate	3 DOUBLES	meters
38-41	Altitude	SINGLE	meters
42	Time stamp code	BYTE	---

3.3.1.32 **91** Request a Waypoint from TRIMPACK

Requests the position coordinates and other information for one of 26 waypoints stored in TRIMPACK. Response is packet 90.

Byte#	Item	Type	Units
0	Waypoint Number (0-25)	BYTE	---

3.3.1.33 **99** Load Set-up Parameters

Sends set-up parameters into the TRIMPACK. Response is 92 or 93 (acknowledge packets).

Byte#	Item	Type	Units
0	Datum (see below)	BYTE	---
1-2	Local/UTC time offset	INTEGER	Hrs.
3	Distance units (see below)	BYTE	---
4	Azimuth units (see below)	BYTE	---
5	Coordinate System (see below)	BYTE	---
6	Azimuth reference (see below)	BYTE	---

Byte 0: Select datum number (0-49) from the list in paragraph 5.3.1.2.

		distance	velocity	altitude
Byte 3:	0 = Metric	kilometers (dm)	km/hr	meters
	1 = English	miles	mi/hr	feet
	2 = Nautical	nautical miles	knots (kts)	feet

Byte 4:
0 = Degrees
1 = Mils
2 = Radians

Byte 5:
0 = Degrees, min, sec
1 = Degrees, min
2 = UTM
3 = MGRS

Byte 6:
0 = True North
1 = Magnetic North

3.3.1.34 **9A** Request Set-up Parameters from TRIMPACK

Requests the set-up parameters being used in the TRIMPACK. Response is packet 99.

3.3.2 Packets Sent By The TRIMPACK To The User

The table below provides the packet ID numbers sent by the TRIMPACK to the user, a short description of each packet, and an indication of when the packet is sent. Details are provided for each packet type in the following sections.

Packets Sent By The TRIMPACK To The User

Id (hex)	Description	When Sent			
		Power-up	Automatic	If selected	Response to Packet Number
40	almanac data for specified sat		X		20
41	GPS time	X (1)	X (1)		21
42	single-precision XYZ position	X (2)		X	25, 37
43	velocity fix (XYZ ECEF)			X	37
44	satellite selection, PDOP, mode		X		24
45	software version information	X			1F, 25
46	health of TRIMPACK	X	X		25, 26
47	signal level for all satellites				27
48	GPS system message				28
49	almanac health page for all sats		X		29
4A	single-precision LLA position	X (2)		X	25, 37
4B	machine code/status	X	X		25, 26
4C	report operating parameters				2C
4D	oscillator offset		X		2D
4E	response to set GPS time				2E
53	A-to-D readings				33
54	one-satellite bias & bias rate		X		22
55	I/O options				35
56	velocity fix (ENU)			X	37
57	information about last computed fix				37
58	GPS system data/acknowledge				38
59	sat enable/disable & health heed				39
5A	raw measurement data		X		3A
5B	satellite ephemeris status		X		3B
5C	satellite tracking status				3C
5F	severe failure report		X		
83	double-precision XYZ position	X (2)		X	25, 37
84	double-precision LLA position	X (2)		X	25, 37
90	waypoint information				91
92	acknowledge 9X packet series				90
93	negative acknowledge				90
99	set-up parameters				9A

Notes: (1) If the current GPS time is not known, this packet is not sent at power-up or automatically.

(2) At turn-on, the TRIMPACK sends packets 42 and 4A if the I/O single-precision-of-position option is selected and sends packets 83 and 84 if the I/O double-precision-of-position option is selected. At power-up, these packets are sent with negative time-of-fix.

3.3.2.1 **40** Almanac Data Page

This packet provides almanac data for a single satellite. The TRIMPACK sends this packet on request (packet 20 hex) and when the data is received from a satellite. The data format is shown below.

Byte #	Item	Type	Units
0	satellite	BYTE	(identification number)
1	T_zc	SINGLE	seconds
5	week number	INTEGER	weeks
7	eccentricity	SINGLE	(dimensionless)
11	T_oa	SINGLE	seconds
15	i_o	SINGLE	radians
19	OMEGA_dot	SINGLE	radians/second
23	square root A	SINGLE	$(\text{meters})^{1/2}$
27	OMEGA o	SINGLE	radians
31	omega	SINGLE	radians
35	M o	SINGLE	radians

These symbols are defined in ICD-GPS-200.

T_zc is normally positive. If no almanac data is available for this satellite, then T_zc is negative. T_zc and the week number in this packet refer to the Z-count time and week number at the time the almanac was received. The remaining items are described in the ICD-GPS-200.

3.3.2.2 **41** GPS Time

This packet provides the current GPS time of week and the week number. The TRIMPACK sends this packet in response to packet 21 hex and during an update cycle. Update cycles occur every 15 seconds when not doing fixes and occur every 150 seconds when doing fixes. The data format is shown below.

Byte #	Item	Type	Units
0-3	GPS time of week	SINGLE	seconds
4-5	GPS week number	INTEGER	weeks
6-9	GPS/UTC offset	SINGLE	seconds

Note that GPS time differs from UTC by a variable integral number of seconds. UTC = (GPS time) - (GPS/UTC offset).

The GPS week number reference is Week # 0 starting January 6, 1980.

The seconds count begins with "0" each Sunday morning at midnight. A negative indicated time-of-week indicates that time is not yet known; in that case, the packet is sent only on request. The following table shows the relationship between the information in packet 41, and the packet 46 status code.

approx time accuracy	time source	sign (TOW)	packet 46 status code
none	no time at all	-	01 hex
unknown	approximate time from real-time clock or packet 2E	+	01 hex
20 to 50 msec + clock drift	time from satellite	+	not 01 hex
full accuracy	time from GPS solution	+	00 hex

Application note: Since the TRIMPACK has real-time clock hardware with battery back-up, the time-of-week is unknown (and its indicated value is set negative) only if the real-time clock has failed or has been cleared (for example, cleared intentionally by packet 1E), and time has not been provided with packet 2E. If the time has come from a properly set real-time clock or from packet 2E, then the indicated time-of-week is positive, and the packet 46 status code byte is 01 hex until the TRIMPACK obtains time from a satellite, and thus time is considered only approximate. For the most accurate GPS time, before using the GPS time from packet 41, verify that the packet 46 status code is 00 hex ("Doing position fixes").

3.3.2.3 **42** Single-precision Position Fix, XYZ ECEF

This packet provides current GPS position fix in XYZ ECEF coordinates. If the I/O "position" option is set to "XYZ ECEF" and the I/O "precision-of-position output" is set to single-precision, then the TRIMPACK sends this packet each time a fix is computed. The data format is shown below.

Byte #	Item	Type	Units
0-3	X	SINGLE	meters
4-7	Y	SINGLE	meters
8-11	Z	SINGLE	meters
12-15	time-of-fix	SINGLE	seconds

The time-of-fix is in GPS time or UTC as selected by the I/O "timing" option. At start-up, this packet or packet 83 is also sent with a negative time-of-fix to report the current known position.

Packet 83 provides a double-precision version of this information.

3.3.2.4 **43** Velocity Fix, XYZ ECEF

This packet provides current GPS velocity fix in XYZ ECEF coordinates. If the I/O "position" option is set to "XYZ ECEF, then the TRIMPACK sends this packet each time a fix is computed if selected by the I/O "timing" option. The data format is shown below.

Byte #	Item	Type	Units
0-3	X velocity	SINGLE	meters/second
4-7	Y velocity	SINGLE	meters/second
8-11	Z velocity	SINGLE	meters/second
12-15	bias rate	SINGLE	meters/second
16-19	time-of-fix	SINGLE	seconds

The time-of-fix is in GPS time or UTC as selected by the I/O "timing" option.

3.3.2.5 **44** Satellite Selection

This packet provides a list of satellites used for position fixes by the TRIMPACK; the packet also provides the PDOP, HDOP, and VDOP of that set and provides the current mode (automatic or manual, 3-D or 2-D). The TRIMPACK sends this packet in response to packet 24 hex and whenever a new satellite selection is attempted. The TRIMPACK attempts a new selection every 30 seconds and whenever satellite availability and tracking status change. The data format is shown below.

Byte #	Item	Type	Value	Meaning
0	Mode	BYTE	01 hex	Auto, 1-satellite, 0-D
			03 hex	Auto, 3-satellite, 2-D
			04 hex	Auto, 4-satellite, 3-D
			11 hex	Manual, 1-satellite, 0-D
			13 hex	Manual, 3-satellite, 2-D
			14 hex	Manual, 4-satellite, 3-D
1-4	4 satellite numbers	4 BYTES		4 satellite numbers
5-8	PDOP	SINGLE		PDOP
9-12	HDOP	SINGLE		HDOP
13-16	VDOP	SINGLE		VDOP
17-20	TDOP	SINGLE		TDOP

PDOP value of zero indicates that the TRIMPACK is not doing fixes, usually because there are not enough healthy usable satellites for position fixes. In this case, the satellite number list contains up to four of the satellites which are usable. Empty satellite number-bytes contain zero. Negative PDOP values indicate that the PDOP is greater than the PDOP mask value and therefore the TRIMPACK is not performing fixes.

3.3.2.6 **45** Software Version Information

This packet provides information about the version of software in the Navigation and Signal Processors. The TRIMPACK sends this packet after power-on and in response to packet 1F hex. The data format is two 5-byte sequences, each of which has the format shown below.

Byte #	Item	Type
0	Major version number	BYTE
1	Minor version number	BYTE
2	Month	BYTE
3	Day	BYTE
4	Year number minus 1900	BYTE

The first 5 bytes refer to the Navigation Processor and the second 5 bytes refer to the Signal Processor.

3.3.2.7 **46** Health of TRIMPACK

This packet provides information about the satellite tracking status and the operational health of the TRIMPACK. The TRIMPACK sends this packet after power-on or software-initiated resets, in response to packet 26 hex, during an update cycle, when a new satellite selection is attempted, and when the TRIMPACK detects a change in its health. Packet 4B hex is always sent with this packet. The data format is given in the following table.

Byte #	Item	Type	Byte value	Meaning
0	Status code	BYTE		
			00 hex	Doing position fixes
			01 hex	Don't have GPS time yet
			02 hex	Not used
			03 hex	PDOP is too high
			08 hex	No usable satellites
			09 hex	Only 1 usable satellite
			0A hex	Only 2 usable satellites
			0B hex	Only 3 usable satellites
			0C hex	6-Ch TRIMPACK only: The chosen satellite is unusable. (4)
1	Error codes	BYTE		

The error codes are encoded into individual bits within the byte. The bit positions and their meanings are shown below.

Bit Position	Meaning if bit value = 1
0 (LSB)	Battery back-up failed (1)
1	Signal Processor error (1)
2	Alignment error, channel or chip 1 (1)
3	Alignment error, channel or chip 2 (1)
4	Antenna feedline fault (2)
5	Excessive ref freq error (3)
6	(Unused)
7 (MSB)	(Unused)

Notes: (1) After this error is detected, its bit remains set until the TRIMPACK is reset.

(2) This bit follows the current status of the antenna feedline fault-detection circuitry.

(3) This bit is "1" if the last computed reference frequency error indicated that the reference oscillator is out of tolerance. (Packet 2D requests the oscillator offset and packet 4D returns the oscillator offset to the user.)

(4) This message is used in the 6-channel TRIMPACK only. This message occurs when the one-satellite mode is in effect and a specific satellite has been chosen with packet 34 hex but that satellite is unusable.

3.3.2.8 47 Signal Levels for all Satellites

This packet provides received signal levels for all satellites currently being tracked or on which tracking is being attempted (i.e., above the elevation mask and healthy according to the almanac). The TRIMPACK sends this packet only in response to packet 27 hex. The data format is shown below

Byte #	Item	Type	Units
0	Count	BYTE	
1	Satellite number 1	BYTE	
2- 5	Signal level 1	SINGLE	
6	Satellite number 2	BYTE	
7-10	Signal level 2	SINGLE	
(etc)	(etc)	(etc)	

Up to 12 satellite number/signal level pairs may be sent, indicated by the count field. Signal level is normally positive. If it is zero then that satellite has not yet been acquired. If it is negative then that satellite is not currently in lock. The absolute value of signal level field is the last known signal level of that satellite.

The signal level provided in this packet is a linear measure of the signal strength after correlation or despreading.

3.3.2.9 48 GPS System Message

This packet provides the 22-byte ASCII message carried in the GPS satellite navigation message. The TRIMPACK sends this packet in response to packet 28 hex and when this data is received from a satellite.

The message effectively is a bulletinboard from the Air Force to GPS users. The format is free-form ASCII. The message may be blank.

3.3.2.10 49 Almanac Health Page

This packet provides health information on 32 satellites. Packet data consists of 32 bytes each containing the 6-bit health from almanac page 25. First byte is for satellite #1, and so on. The TRIMPACK sends this packet in response to packet 29 hex and when this data is received from a satellite.

Byte #	Item
1	health of satellite # 1
2	health of satellite # 2
.	.
.	.
32	health of satellite # 32

In each data byte of this packet, a value "0" indicates that the satellite is healthy; all other values indicate that the satellite is unhealthy.

3.3.2.11 4A Single-precision LLA Position Fix

This packet provides current GPS position fix in LLA (latitude, longitude, and altitude) coordinates. If the I/O "position" option is set to "LLA" and the I/O "precision-of-position output" is set to single-precision, then the TRIMPACK sends this packet each time a fix is computed. The data format is shown below

Byte #	Item	Type	Units
0-3	Latitude	SINGLE	radians; + for north, - for south
4-7	Longitude	SINGLE	radians; + for east, - for west
8-11	Altitude	SINGLE	meters
12-15	Clock Bias	SINGLE	meters
16-19	Time-of-Fix	SINGLE	seconds

Altitude is referred to the WGS-84 ellipsoid or the MSL Geoid, depending on which I/O "LLA altitude" option is selected.

The time-of-fix is in GPS time or UTC, depending on which I/O "timing" option is selected.

This packet also is sent at start-up with a negative time-of-fix to report the current known position.

Packet 84 provides a double-precision version of this information.

CAUTION

When converting from radians to degrees, significant and readily visible errors will be introduced by use of an insufficiently precise approximation for the constant π (PI). The value of the constant PI as specified in ICD-GPS-200 is 3.1415926535898.

3.3.2.12 **4B** Machine/Code ID and Additional Status

The TRIMPACK transmits this packet in response to packets 25 and 26 and following a change in state. In conjunction with packet 46, "health of TRIMPACK," this packet identifies the TRIMPACK and may present error messages. The machine ID can be used by equipment communicating with the TRIMPACK to determine the type of TRIMPACK to which the equipment is connected. Then the interpretation and use of packets can be adjusted accordingly.

Byte #	Item	Type	Value	Meaning
0	Machine ID	BYTE	6	2-channel TRIMPACK
			10	3-channel TRIMPACK
1	Status 1	BYTE		

The error codes are encoded into individual bits within the byte. The bit positions and their meanings are shown below.

Bit Position	Meaning if bit value = 1
0 (LSB)	Synthesizer Fault
1	Battery Powered Time Clock Fault
2	A-to-D Converter Fault
3	The almanac stored in the TRIMPACK, is not complete and current.
4-7	Not used

2	Status 2	BYTE	Not used; for future expansion

3.3.2.13 **4C** Report Operating Parameters

This packet provides several operating parameter values of the TRIMPACK. The TRIMPACK sends this packet in response to packet 2C hex. The data format is shown below.

The dynamics code indicates the expected vehicle dynamics and is used to assist the initial solution.

The elevation angle mask determines the lowest angle at which the TRIMPACK tries to track a satellite.

The signal level mask sets the required signal level for a satellite to be used for position fixes.

The PDOP mask sets the maximum PDOP with which position fixes are calculated. The PDOP switch sets the threshold for automatic 3-D/2-D mode. If 4 or more satellites are available and the resulting PDOP is not greater than the PDOP mask value, then 3-dimensional fixes are calculated.

Byte #	Item	Type	Units	Default
0	Dynamics code	BYTE		
	Value: 0 — Meaning: Current value is left unchanged. — Assumed velocity:			
	1 — land (default) — < 120 knots			
	2 — sea — < 50 knots			
	3 — air — < 600 knots			
	4 — static — stationary			
1-4	Elevation angle mask	SINGLE	radians	0.1745 or 10^{o}
5-8	Signal level mask	SINGLE	---	6
9-12	PDOP mask	SINGLE	---	12
13-16	PDOP switch (3-D or 2-D)	SINGLE	---	8

A negative value in a SINGLE field leaves that current setting unchanged.

This information is held in battery-backed memory.

3.3.2.14 **4D** Oscillator Offset

This packet provides the current value of the TRIMPACK master oscillator offset in Hertz at carrier. This packet contains one SINGLE number. The TRIMPACK sends this packet in response to packet 2D hex. The permissible offset varies with the TRIMPACK unit.

3.3.2.15 **4E** Response to Set GPS Time

Indicates whether the TRIMPACK accepted the time given in a Set GPS time packet. The TRIMPACK sends this packet in response to packet 2E hex. This packet contains one byte.

Value	Meaning
ASCII "Y"	The TRIMPACK accepts the time entered via packet 2E. The TRIMPACK has not yet received the time from a satellite.
ASCII "N"	The TRIMPACK does not accept the time entered via packet 2E. The TRIMPACK has received the time from a satellite and uses that time. The TRIMPACK disregards the time in packet 2E.

3.3.2.16 **53** A-to-D Readings

Provides eight channels for output of various signal values in system. This packet is in response to 33 hex. The packet format and channel descriptions are as follows:

Byte	Item	Type	Units
0-3	Temperature (0.01V/°K)	SINGLE	Volts
4-7	Synthesizer Control Voltage	SINGLE	Volts
8-11	IF Signal Level	SINGLE	Volts
12-15	External Antenna Voltage	SINGLE	Volts
16-19	Internal Battery Voltage divided by 3.56	SINGEL	Volts
20-23	Display Temperature (0.01V/°K)	SINGLE	Volts
24-27	Internal Antenna Voltage	SINGLE	Volts
28-31	+5V	SINGLE	Volts

3.3.2.17 **54** One-Satellite Bias and Bias Rate

The TRIMPACK sends this packet to provide the computed clock-only solution when the TRIMPACK is in the manual or automatic one-satellite mode.

Byte	Item	Type	Units
0-3	Bias	SINGLE	meters
4-7	Bias rate	SINGLE	meters/second
8-11	Time of fix	SINGLE	seconds

The bias is the offset of the TRIMPACK internal time clock from GPS time. Bias is expressed as meters of apparent range from the satellites. It is used to correct the one PPS output. Bias rate is the frequency error of the TRIMPACK internal oscillator. It is expressed as apparent range rate.

CAUTION

For accurate interpretation of the propagation delay, the precise constant for the speed of light must be used. The WGS-84 value for the speed of light is 299,792,458 meters per second.

3.3.2.18 **55** I/O Options

This packet provides current I/O options in effect in response to packet 35 request. The data format is the same as for packet 35 hex and is repeated below for convenience.

Byte#	Parameter Name	Bit Position	Default Bit Value	Option	Associated Packet
0	position	0 (LSB)	1	XYZ ECEF Output 0: off 1: on	42 or 83
		1	0	LLA Output 0: off 1: on	4A or 84
		2	0	LLA ALT Output 0: HAE WGS-84 1: MSL geoid	4A or 84
		3	0	ALT input 0: HAE WGS-84 1: MSL geoid	2A
		4	0	precision-of-position output 0: Send single-precision packet 42 and/or 4A. 1: Send double-precision packet 83 and/or 84.	
		5-7	0	unused	
1	velocity	0	1	XYZ ECEF Output 0: off 1: on	43
		1	0	ENU Output 0: off 1: on	56
		2 - 7	0	unused	
2	timing	0	0	time type 0: GPS time 1: UTC	
		1	0	fix computation time 0: ASAP 1: next integer sec	
		2	0	output time 0: when computed 1: only on request	37
		3 - 7	0	unused	
3	Auxiliary	0	0	raw measurements 0: off 1: on	5A
		1-7	0	unused	

Glossary for the table above:

ALT:	Altitude	WGS-84:	Earth model (ellipsoid)
ECEF:	Earth-centered, Earth-fixed	MSL geoid:	Earth (mean sea level) model
XYZ:	Cartesian coordinates	ENU:	East-North-up (same as LLA)
LLA:	latitude, longitude, altitude	UTC:	coordinated universal time
HAE:	height above ellipsoid		

3.3.2.19 **56** Velocity Fix, East-North-Up (ENU)

If East-North-Up (ENU) coordinates have been selected for the I/O "position" option, the TRIMPACK sends this packet under the following conditions: (1) each time that a fix is computed; (2) in response to packet 37 hex (last known fix). The data format is shown below.

Byte #	Item	Type	Units
0-3	East Velocity	SINGLE	m/s; + for east, - for west
4-7	North Velocity	SINGLE	m/s; + for north, - for south
8-11	Up Velocity	SINGLE	m/s; + for up, - for down
12-15	Clock Bias Rate	SINGLE	m/s
16-19	Time-of-Fix	SINGLE	seconds

The time-of-fix is in GPS or UTC time as selected by the I/O "timing" option.

3.3.2.20 **57** Information About Last Computed Fix

This packet provides information concerning the time and origin of the previous position fix. The TRIMPACK sends this packet, among others, in response to packet 37 hex. The data format is shown below.

Byte #	Item	Type	Units
0	Source of information	BYTE	---

Value	Meaning
00 hex	none
01 hex	regular fix
02 hex	initialization diagnostic
04 hex	initialization diagnostic
05 hex	entered by packet 23 or 2B
06 hex	entered by packet 31 or 32
08 hex	default position after RAM battery fail

1	Manuf. diagnostic	BYTE	---
2-5	Time of last fix	SINGLE	seconds, GPS time
6-7	Week of last fix	INTEGER	weeks, GPS time

3.3.2.21 **58 Satellite System Data/Acknowledge from TRIMPACK**

This packet provides GPS data (almanac, ephemeris, etc.). The TRIMPACK sends this packet under the following conditions: (1) on request; (2) in response to packet 38 hex (acknowledges the loading of data). The data format is shown below.

Byte #	Item	Type	Byte Value	Meaning
0	Operation	BYTE		
			0	Acknowledge, can't use
			1	Acknowledge
			2	Data Out
			3	No Data on SV
1	Type of data	BYTE		
			1	not used
			2	Almanac
			3	Health page, T_oa, WN_oa
			4	Ionosphere
			5	UTC
			6	Ephemeris
2	Sat PRN #	BYTE		
			0	data that is not satellite-ID-specific
			1 to 32	satellite PRN number
3	length *(n)*	BYTE		number of bytes of data to be loaded
4 to n+3	data	*n* BYTES		

3.3.2.22 **59** Status of Satellite Disable or Ignore Health

Normally the TRIMPACK selects satellites for use in GPS solution according to whether the candidate satellites are in good health and whether they satisfy the mask values for elevation angle, signal level, and PDOP. This packet reads back whether the user has told the TRIMPACK to disable unconditionally the selection of any particular satellite and whether the user has told the TRIMPACK to ignore the health of any particular satellite that otherwise is acceptable for selection. The TRIMPACK sends this packet in response to packet 39 hex. The data format is shown below.

Byte #	Item	Type	Byte Value	Meaning
0	Operation	BYTE		
			3	The remaining bytes tell whether the TRIMPACK is allowed to select each satellite.
			6	The remaining bytes tell whether the TRIMPACK heeds or ignores each satellite's health as a criterion for selection.
1 to 32	Satellite #	32 BYTES (1 byte per satellite)		(Depends on byte 0 value.)
			0	Enable satellite selection or heed satellite's health. Default value.
			1	Disable satellite selection or ignore satellite's health.

This information is not held in battery-backed memory. At power-on and after a reset, the default values are set for all satellites.

3.3.2.23 **5A** Raw Measurement Data

This packet provides raw GPS measurement data. If the I/O "auxiliary" option has been selected, the TRIMPACK sends this data automatically as measurements are taken. The TRIMPACK also sends this packet in response to packet 3A hex. The data format is shown below.

Byte #	Item	Type	Units
0	Satellite PRN Number	BYTE	-----
1	Sample Length	SINGLE	msec
5	Signal Level	SINGLE	
9	Code phase	SINGLE	1/16th chip
13	Doppler	SINGLE	Hertz
17	Time of Measurement	DOUBLE	sec

3.3.2.24 **5 B** Satellite Ephemeris Status

This packet provides information on the status of the ephemeris in the TRIMPACK for a specified satellite. The TRIMPACK sends this packet in response to packet 3B and when the TRIMPACK receives a new ephemeris. (The age of the ephemeris is indicated by the *Issue Of Data, Ephemeris*, or *IODE*, which appears in the navigation data.) The data format is shown below.

Byte #	Item	Type	Byte Value	Meaning or Units
0	satellite PRN #	BYTE	1 to 32	
1-4	GPS time of collection	SINGLE		seconds
5	ephemeris health	BYTE	(6 bits)	
6	IODE	BYTE		
7	t_oe (time of ephemeris)	SINGLE		seconds
11	curve fit interval flag	BYTE		
12-15	satellite user range accuracy (URA)	SINGLE	(4 bits)	

Reference for all fields above: ICD-GPS-200.

3.3.2.25 **5C** Satellite Tracking Status

This packet provides tracking status data for a specified satellite. Some of the information is very implementation-dependent and is provided mainly for diagnostic purposes. The TRIMPACK sends this packet in response to packet 3C hex. The data format is shown below.

Byte #	Item	Type	Units
0	satellite PRN number	BYTE	number, 1 to 32
1	channel and slot code	BYTE	

This is an internal coding of the hardware tracking channel and of the slot within the channel to which the specified satellite currently is assigned.

Bit Position	Value	Meaning
0 to 2 (LSB)		
	000 (LSB)	slot 1
	001	slot 2
	010	slot 3
	011	slot 4
	100	slot 5
	101	slot 6

3 to 7: channel number, starting with zero

Bits 3-7	Channel	Used by
00000	1	all TRIMPACK
00001	2	3-channel TRIMPACK only
00010	3	3-channel TRIMPACK only
00011	4	3-channel TRIMPACK only
00100	5	3-channel TRIMPACK only
00101	6	3-channel TRIMPACK only
10000	2	2-channel TRIMPACK only

2	acquisition flag	BYTE	

Byte Value	Meaning
0	never acquired
1	acquired
2	re-opened search

3	ephemeris flag	BYTE	

Byte Value	Meaning
0	flag not set
≠ 0	good ephemeris for this satellite (< 4 hours old, good health)

4-7	signal level	SINGLE	same as in packet 46 hex
8-11	GPS time of last msmt	SINGLE	seconds

Byte Value	Meaning
<0	no measurements have been taken
≥0	center of the last measurement taken from this satellite

12-15	elevation	SINGLE	radians

Approximate elevation of this satellite above the horizon. Updated about every 15 seconds. Used for searching and computing measurement correction factors.

16-19	azimuth	SINGLE	radians

Approximate azimuth from true north to this satellite. Updated typically about every 3 to 5 minutes. Used for computing measurement correction factors.

20 old measurement flag BYTE

Byte Value	Meaning
0	flag not set
≠ 0	The last measurement is too old to use for a fix computation.

21 integer msec flag BYTE

Byte Value	Meaning
0	don't have good knowledge of integer millisecond range to this satellite
1	msec from sub-frame data collection
2	verified by a bit crossing time
3	verified by a successful position fix
4	suspected msec error

22 bad data flag BYTE

Byte Value	Meaning
0	flag not set
1	bad parity
2	bad ephemeris health

23 data collect flag BYTE

Byte Value	Meaning
0	flag not set
≠0	The TRIMPACK currently is trying to collect data from this satellite.

3.3.2.26 **5F** Failure Report

If a severe failure prevents the TRIMPACK from operating, the TRIMPACK sends this packet at turn-on if the failure does not preclude doing so. Generally, the TRIMPACK sends nothing following this packet. The packet data bytes consist of "02" followed by an ASCII text message which describes the failure.

3.3.2.27 **83** Double-precision XYZ Position Fix And Bias Information

This packet provides current GPS position fix in XYZ ECEF coordinates. If the I/O "position" option is set to "XYZ ECEF" and the I/O double-precision-of-position option is selected, the TRIMPACK sends this packet each time a fix is computed. The data format is shown below.

Byte #	Item	Type	Units
0-7	X	DOUBLE	meters
8-15	Y	DOUBLE	meters
16-23	Z	DOUBLE	meters
24-31	clock bias	DOUBLE	meters
32-35	time-of-fix	SINGLE	seconds

The time-of-fix is in GPS time or UTC, as selected by the I/O "timing" option. At start-up, if the I/O double-precision-of-position option is selected, this packet is also sent with a negative time-of-fix to report the current known position.

Packet 42 provides a single-precision version of this information.

3.3.2.29 **84** Double-precision LLA Position Fix And Bias Information

This packet provides current GPS position fix in LLA coordinates. If the I/O "position" option is set to "LLA" and the double-precision-of-position option is selected, the TRIMPACK sends this packet each time a fix is computed. The data format is shown below.

Byte #	Item	Type	Units
0-7	latitude	DOUBLE	radians; + for north, - for south
8-15	longitude	DOUBLE	radians; + for east, - for west
16-23	altitude	DOUBLE	meters
24-31	clock bias	DOUBLE	meters
32-35	time-of-fix	SINGLE	seconds

The time-of-fix is in GPS time or UTC, as selected by the I/O "timing" option. At start-up, this packet is also sent with a negative time-of-fix to report the current known position.

Packet 4A provides a single-precision version of this information.

CAUTION

When converting from radians to degrees, significant and readily visible errors will be introduced by use of an insufficiently precise approximation for the constant π (PI). The value of the constant PI as specified in ICD-GPS-200 is 3.1415926535898.

3.3.2.30 **90** Waypoint Information

Provides waypoint information for one of 26 waypoints stored in the TRIMPACK. Sent in response to packet 91.

Byte	Item	Type	Units
0-1	Waypoint number (0-25)	INTEGER	---
2-13	User label field (12 characters)	ASCII	---
14-37	XYZ (WGS-84) coordinate	3 DOUBLES	---
38-41	Altitude	SINGLE	---
42	Time stamp code	BYTE	---

3.3.2.31 **92** Acknowledge 9X Packet Series

Indicates that the previous 9X packet was processed correctly.

3.3.2.32 **93** Negative Acknowledge

The previous 9X packet was not able to be processed, possible due to a transmission error or the requested data was out-of-bounds. If the TRIMPACK receives this, it will retry sending the previous 9X packet up to 5 times before aborting.

3.3.2.33 **99** Set-up Parameters

Provides set-up parameters stored in the TRIMPACK. Sent in response to 9A.

Byte	Item	Type	Units
0	Datum (see below)	BYTE	---
1-2	Local/UTC time offset	INTEGER	Hrs
3	Distance units (see below)	BYTE	---
4	Azimuth units (see below)	BYTE	---
5	Coordinate System (see below)	BYTE	---
6	Azimuth reference (see below)	BYTE	---

Byte 0: Select datum number (0-49) from list in paragraph 5.3.1.2.

Byte 3:
0 = Metric
1 = English
2 = Nautical

Byte 4:
0 = Degrees
1 = Mils
2 = Radians

Byte 5:
0 = Degrees, min, sec
1 = Degrees, min
2 = UTM
3 = MGRS

Byte 6;
0 = True north
1-Magnetic north

APPENDIX B

MECHANICAL DRAWINGS

OUTLINE DRAWINGS

Figure 1 details the content of the TRIMPACK system. The units which make up the system are shown as installed and cabled for ready reference and ordering.

Each unit which makes up the system is then shown in an individual drawing, Figures 1 to 3. Each of these drawings provides detailed dimensions for size, shape and fastening these elements to each other as well as to the supporting structure.

To further assist in installation, critical specifications are provided. These include such things as torque for installation fasteners and, in the case of the external antenna, a flatness specification which will preclude warpage.

Figure 5 provides the drill template for the external antenna. The use of sealant in lieu of gaskets is left to the installation engineer; however, the recommended sealants are described for compatibility with the antenna surface treatment.

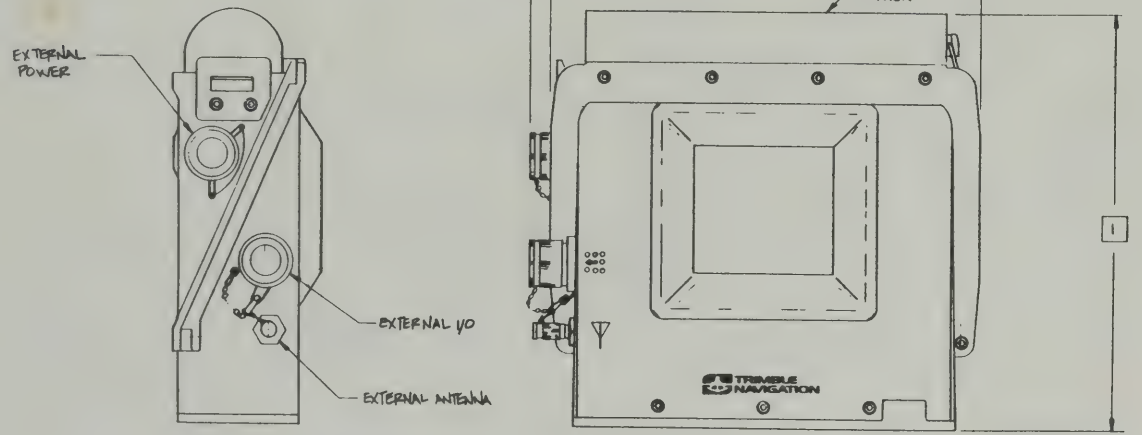
For reference purposes, the complete set of drawings provided are listed below:

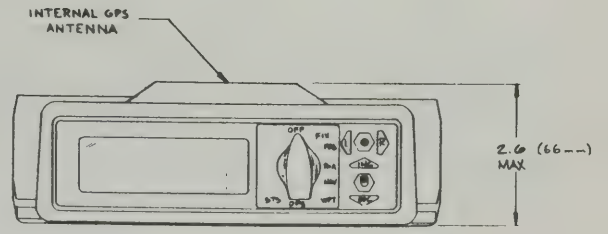
Drawing Number	Title	Figure No.
16768-00, Sht 1 of 3	TRIMPACK Dimensional Specification	1
16768-00, Sht 2 of 3	Installation, TRIMPACK	2
16768-00, Sht 3 of 3	Functional Block Diagram and Interface Definition, TRIMPACK	3
13214-00, Sht 1 & 2	Typical TRIMPACK Vehicle Mount	4
12038, Sht 1 & 2	Installation, GPS Antenna	5
12765-00	Cable Assy, SBNS to Antenna	6
13825-00	Option Vehicle Power Adapter	7
13815-00	Vehicle Power Adapter, TRIMPACK	8
13830-00	Cable Assy, TRIMPACK/VPA	9
13849-00	Cable Assy, Power/Filter, TRIMPACK	10
12792-00	Cable Assy, TRIMPACK/Pwr Fuse nshld	11
12793-00	Cable Assy, TRIMPACK/Ext. I/O	12
13826-00	Cable Assy, TRIMPACK/TRIMPACK I/O	13
12960-00	Assy, Antenna, TANS w/Type N-Conn	14
13033	Base, TANS Antenna Survey Mount	15
12920-00	Assy, Magnetic Mnt Adapter, Mag. Base	16

CAUTION

The drawings provided in Appendix B are for planning purposes only. Before committing to the design of the electrical or mechanical interface, please consult Trimble Navigation Limited.

REVISIONS				
ECN	REV	DESCRIPTION	DATE	APPROVED
	D	RELEASE TO DOC CONTROL REV. A-C NOT DOCUMENTED	11/6/89	J LOVELL





NOTES:

[1] LENGTH DEPENDENT UPON BATTERY PACK OPTION. DIMENSION ARE AS FOLLOWS.

INL P/N	BATTERY PACK	LENGTH
# 14568-00	LITHIUM BATTERY PACK DOUBLE "D" SLEEVE	
13827-00	DUAL BA-5800 PACK	8.8 (224--)
13828-00	SINGLE BA-6800 PACK	7.5 (191--)
13829-00	NICAD PACK	8.8 (224--)

LENGTH W/O BATTERY PACK : 6.4 (163--)

INSTALLS IN 13828-00 SINGLE BA-6800 PACK

PARTS LIST

QTY REQD	PSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
.XX ±
.XXX ±

MATERIAL ~
FINISH ~
NEXT ASSY USED ON
APPLICATION
DO NOT SCALE DRAWING

CONTRACT NO

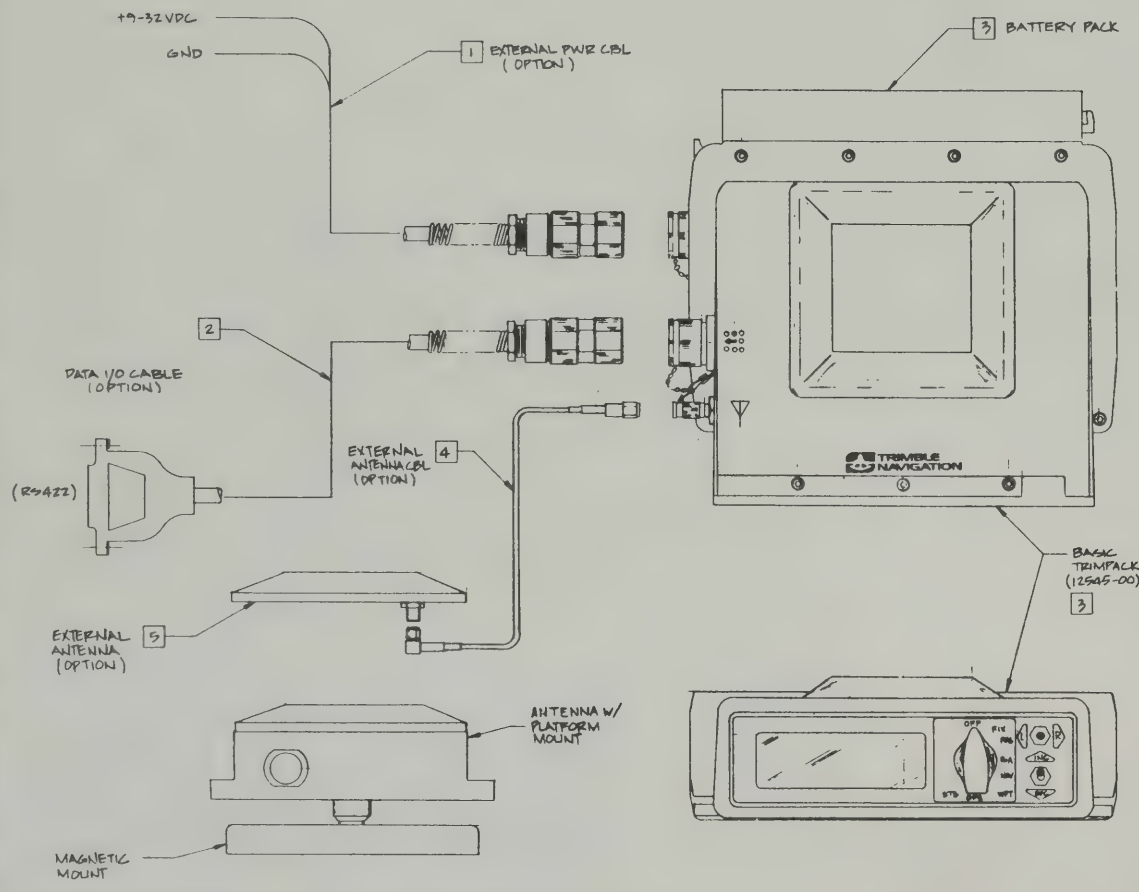
APPROVALS	DATE
DRAWN M. BASEOS	12-5/88
CHECKED D. DICARLO	12/6/88
ISSUED	

TRIMBLE NAVIGATION

TRIMPACK
DIMENSIONAL SPECIFICATION

SIZE D | FSCM NO | DWG NO 16768-00 | REV D
SCALE NTS | SHEET 1 OF 3

ECN	REV	DESCRIPTION	DATE	APPROVED
	D	RELEASE TO DOC. CONTROL REV A-C NOT DOCUMENTED	11/6/89	J LOBELL



NOTES:

1 EXTERNAL POWER OPTIONS INCLUDE:
- 12792-00 EXT PWR CBL NON-FILTERED, FUSED, 2 X 18 AWG
- 13825-00 OPTION. VEHICLE POWER ADAPTER ASSY FOR MIL-STD-461 COMPLIANCE

2 DATA I/O CABLE OPTIONS INCLUDE:
- 12793-00 EXT I/O CBL ASSY RS422
- 13826-00 TRIMPACK TO TRIMPACK DATA EXCHANGE CBL ASSY

3 BATTERY PACK OPTIONS INCLUDE:
- 13827-00 DOUBLE BAG800 BATTERY PACK.
- 13828-00 SINGLE BAG800 BATTERY PACK.
- 14568-00 LITHIUM BATTERY PACK DOUBLE "D" SLEEVE (INSTALLS IN 13828-00)
- 13829-00 NICAD BATTERY PACK

4 6m STANDARD EXTERNAL CABLE OPTION 12765-00, OTHER LENGTHS AND TERMINATIONS AVAILABLE.

5 EXTERNAL ANTENNA OPTIONS INCLUDE:
- 12038-00 GPS ANTENNA (TYPE SMA TERMINATION)
- 12960-00 GPS ANTENNA PLATFORM MOUNT (TYPE N TERMINATION)
- 12920-00 GPS ANTENNA MAGNETIC MOUNT (REQUIRES PLATFORM MOUNT 12960-00)

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES .XX ± .XXX ±

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO

APPROVALS	DATE
DRAWN MB J	12/4/88
CHECKED D. Dickerson	11/4/89
ISSUED	

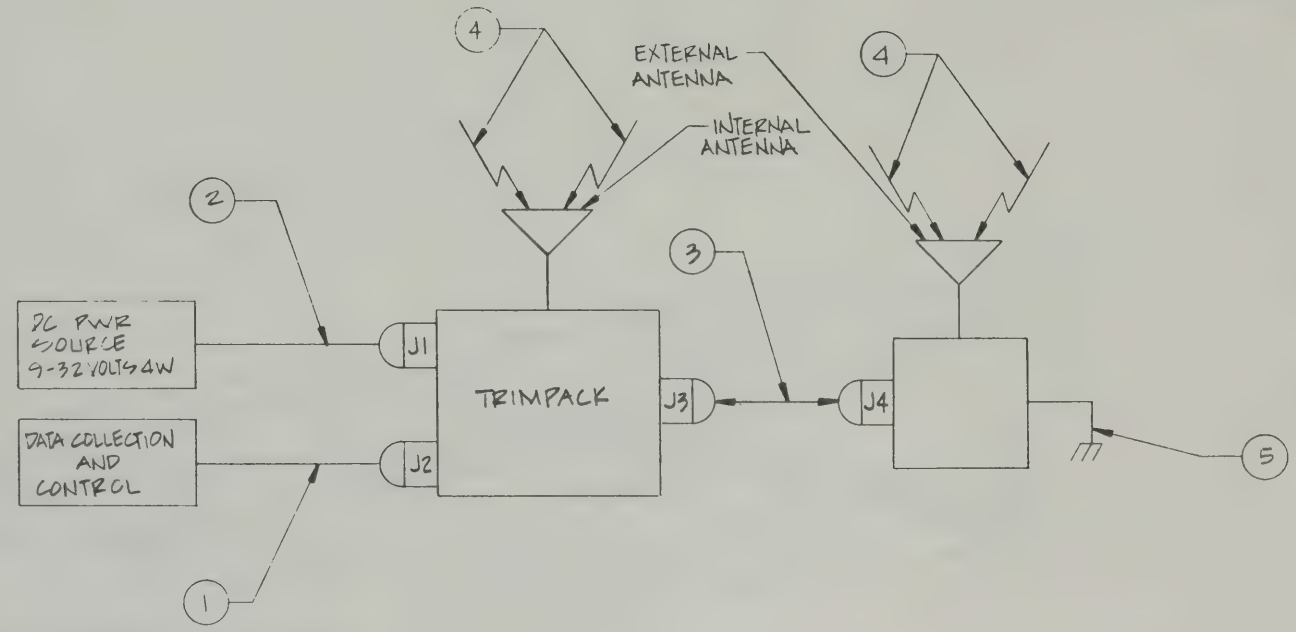
TRIMBLE NAVIGATION

INSTALLATION, TRIMPACK

SIZE D | FSCM NO | DWG NO 16768-00 | REV D

SCALE NTS | SHEET 2 OF 3

REVISIONS				
ECN	REV	DESCRIPTION	DATE	APPROVED
	-	RELEASE TO DOC CONTROL REV. A-C NOT DOCUMENTED	12/89	



NO.	DESCRIPTION	FROM	TO
	RS422	J2	USER
2	DC POWER	USER	J1
3	RF INTFC TRIMPACK TO EX. ANT	J3	J4
4	C/A GPS-2003	SATELLITE	ANTENNA
5	MECHANICAL INTFC	EXT ANT	SUPPORT STRUCTURE

CONNECTOR	DESCRIPTION
J1	TRIMPACK EXTERNAL POWER
J2	TRIMPACK EXTERNAL I/O
J3	TRIMPACK EXTERNAL ANTENNA
J4	EXT. ANTENNA OUTPUT

QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
X/X ± .X ± ±
.XX ± .XXX ±

MATERIAL —

FINISH —

CONTRACT NO

APPROVALS	DATE
DRAWN MBJ	12/4/89
CHECKED D. DICKERSON	11/4/89
ISSUED	

NEXT ASSY | USED ON

APPLICATION | DO NOT SCALE DRAWING

TRIMBLE NAVIGATION

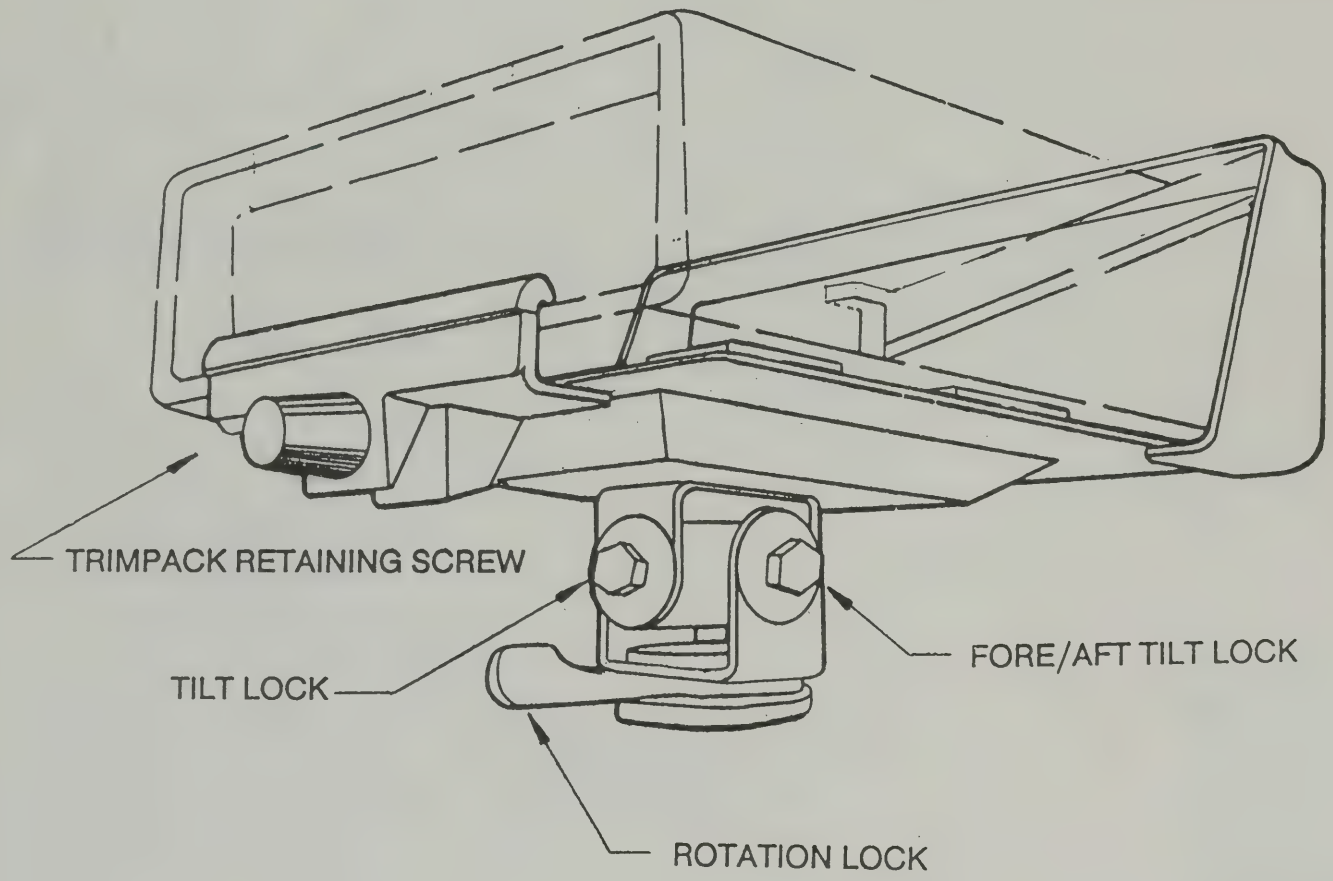
FUNTIONAL BLOCK DIAGRAM AND INTFC DEFINITION TRIMPACK

SIZE C | FSCM NO. | DWG NO. 16768-00 | REV D

SCALE NTS | SHEET 3 OF 3

DWG NO 13210 | SH 3 | REV D

REVISIONS				
	Φ	AS DRAWN		
	A	RELEASED TO DOC CONTROL		



PARTS LIST

TRIMBLE NAVIGATION

TRIMPACK VEHICLE MOUNT

DWG. NO. 13214-00 REV. A

SIZE | FSCM

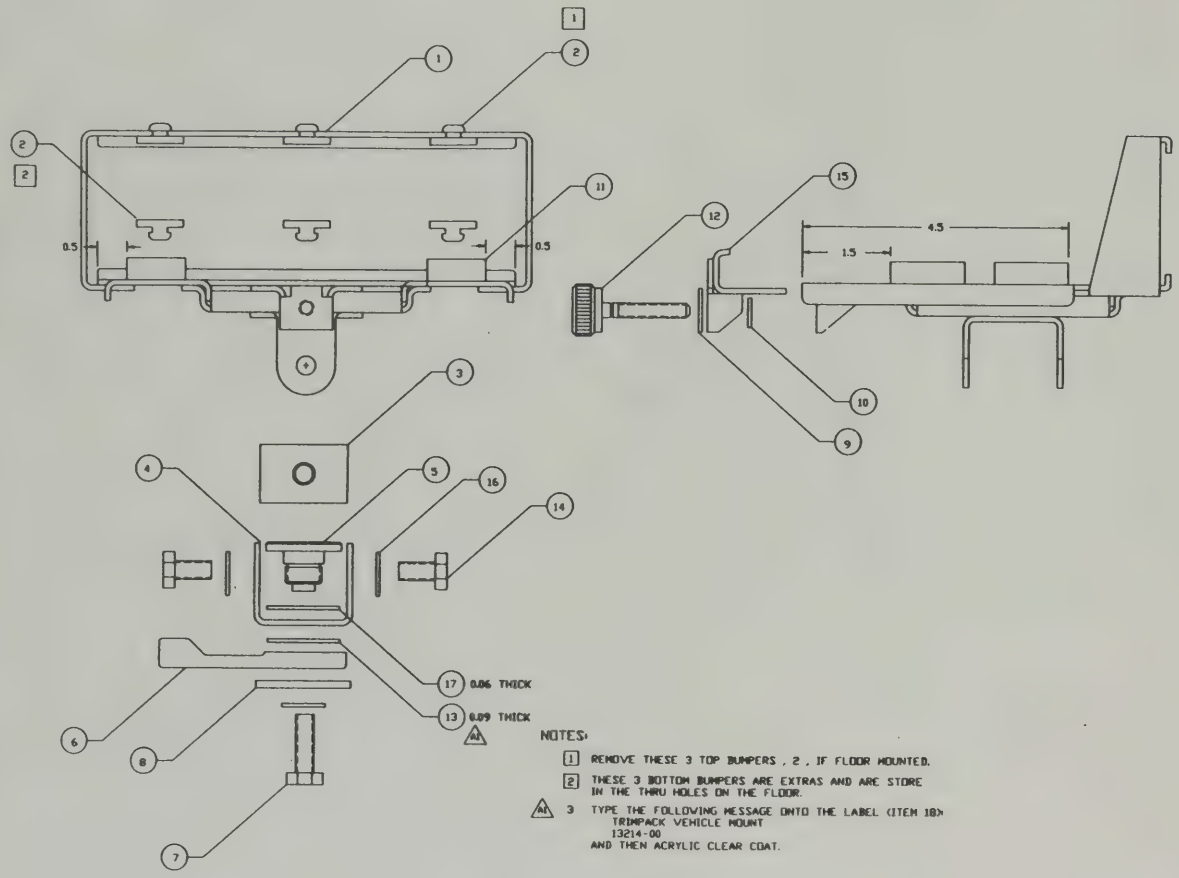
SCALE N/A

SHEET 1 OF 2

APPLICATION

DO NOT SCALE DRAWING

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	1	AS ISSUED.	9/25/89	
	A	RELEASED TO DOC CONTROL.		
1483	A1	ADDED ITEMS 13, 18, AND NOTE 3		



NOTES:

1. REMOVE THESE 3 TOP BUMPERS , 2 , IF FLOOR MOUNTED.
2. THESE 3 BOTTOM BUMPERS ARE EXTRAS AND ARE STORE IN THE THRU HOLES ON THE FLOOR.
3. TYPE THE FOLLOWING MESSAGE ONTO THE LABEL (ITEM 18)
   TRIMPACK VEHICLE MOUNT
   13214-00
   AND THEN ACRYLIC CLEAR COAT.

ITEM	QTY PER ASSY	USED ON	FIND NO. OR IDENTIFYING NO.	DESCRIPTION OR IDENTIFYING NO.	MANUFACTURER'S PART OR IDENTIFYING NO.
18	1			LABEL TNL GENERIC 1 x 2 TYPEABLE	12114
17	1			WASHER FLAT 0.72 ID 1.25 OD .09 THK BLK AL	16203
16	5			WASHER 5/16 ID 3/4 OD AL BLACK ANODIZE	16146
15	1			WASHER 1/4 ID 3/4 OD AL BLACK ANODIZE	16145
14	4			SCREW 5/16-18 x 5/8 HEX HD 18-8 S/S	16144
13	1			WASHER FLAT 0.72 ID 1.25 OD AL BLK ANODIZE	16143
12	1			SCREW THUMB VEHICLE MOUNT TRIMPACK	16139
11	4			PORON PATCH ADHESIVE BACK	16138
10	1			RING RETAINING 0.210 GROOVE DIA S/S	16137
9	1			BRACKET CLAMP VEHICLE MOUNT TRIMPACK	16136
8	1			WASHER DOUBLE "D" VEHICLE MOUNT TRIMPACK	14850
7	1			SCREW, 5/16-18 x 1 HEX HD 18-8 S/S	14848
6	1			LEVER, VEHICLE MOUNT TRIMPACK	14845
5	1			SWIVEL BASE SCREW VEHICLE MOUNT TRIMPACK	14844
4	1			BRACKET, U JOINT VEHICLE MOUNT TRIMPACK	14843
3	1			JOINT, TILT VEHICLE MOUNT TRIMPACK	14842
2	6			BUMPER, VEHICLE MOUNT TRIMPACK	14840
1	1			CAGE VEHICLE MOUNT TRIMPACK	14839

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± / DECIMALS .01 ± .005 ANGLES ° ± '

MATERIAL

FINISH NOTED

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN KYOK LUI	11/2/89
CHECKED	
ISSUED	

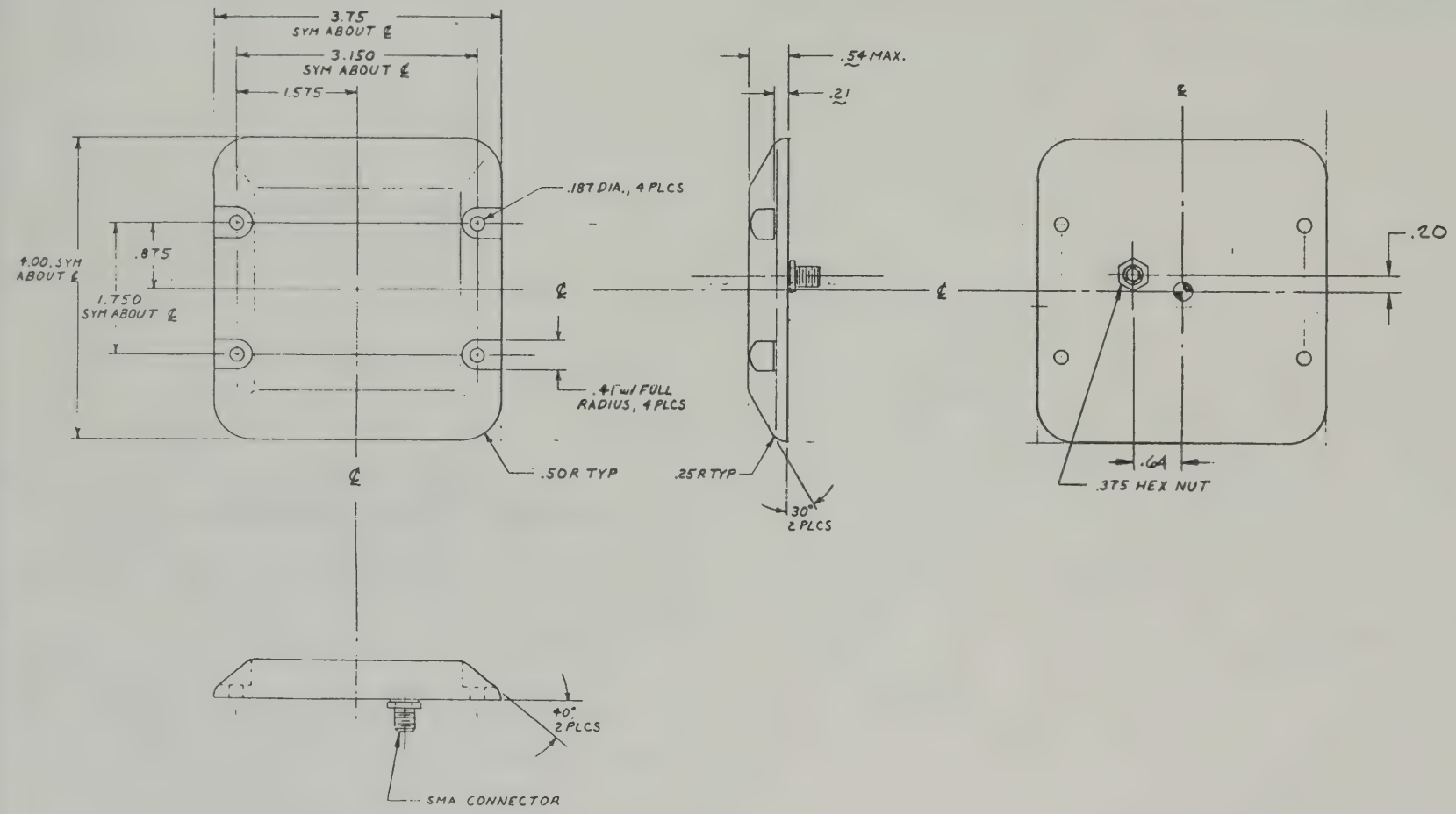
TRIMBLE NAVIGATION

CAGE, TRIMPACK VEHICLE MOUNT

SIZE D | FSCM NO | DWG NO 13214-00 | REV A1

SCALE: FULL | SHEET 2 OF 2

REVISIONS				
ECN	REV	DESCRIPTION	DATE	APPROVED
745	A	RELEASED TO PILOT	11/18/87	JAH
805	B	ADDED GASKET TO SHT 2.	12.9.87	RCS2



PARTS LIST					
QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECS ± ANGLES ±
.XX ± .030
.XXX ± .010

MATERIAL ~

FINISH ~

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN	11/4/87
CHECKED	
ISSUED	

TRIMBLE NAVIGATION

INSTALLATION
GPS ANTENNA

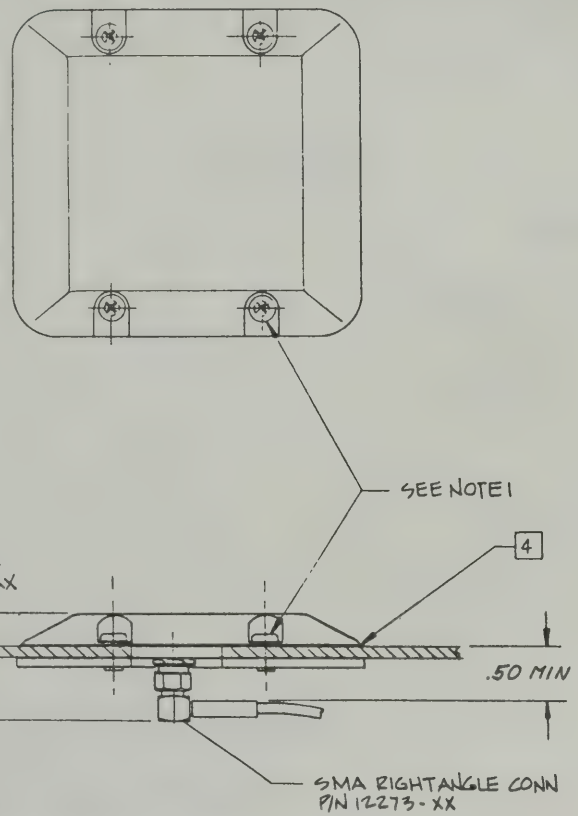
SIZE	FSCM NO.	DWG. NO.	REV.
C		12038-INSTALL	B

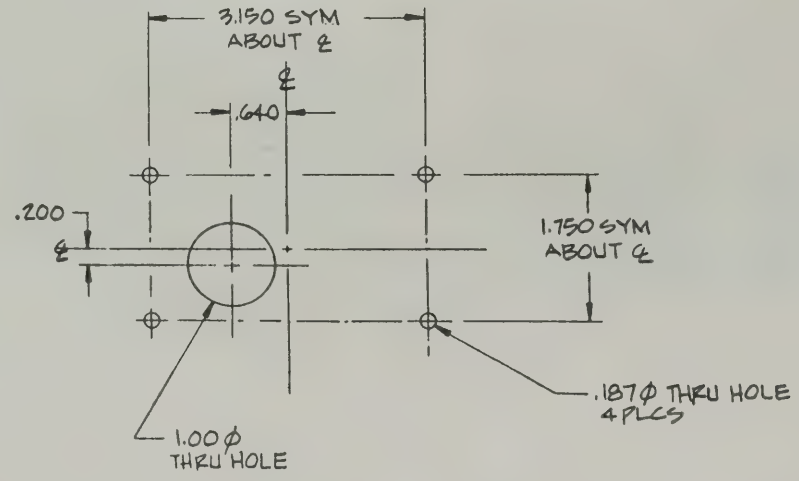
SCALE FULL | SHEET 1 OF 2

12038-INSTALL | SHT 1 | REV B

B-SIZE GRAPHICS - ACCUPRESS REORDER NO 43884

REVISIONS				
ECN	REV	DESCRIPTION	DATE	APPROVED
745	A	REMOVED SHT 3 SCREECH; DRW A WAS 12038-00, SHT 3 OF 3, REVERSE TO PILOT	8/18/87	JAH
805	B	ADDED NOTE 4 AND GASKET	12.19.87	





NOTES:

1. SCREW PAN HEAD CROSS RECESSED #8-32 LENGTH TO SUIT. TORQUE TO 20 IN/LBS. ABOVE LOCKING FRICTION IN LOCKNUT
2. FLATNESS SPECIFICATION ON MATING SURFACE .020.
3. RECOMEND SEAL FOR PRESSURIZED AIRCRAFT. USE CONDUCTIVE NEOPRENE OR SILICONE GASKET.

[4] NEOPRENE IMPREGNATED WOVEN ALUMINUM GASKET SUPPLIED WITH ANTENNA TNL P/N 12549.

QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .01 .XXX ± .010 ANGLES ± °

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN MBJ	6.1.87
CHECKED	
ISSUED	

TRIMBLE NAVIGATION

INSTALLATION GPS ANTENNA

SIZE C | FSCM NO. | DWG. NO. 12038-INSTALL | REV B

SCALE NTS | SHEET 2 OF 2

DWG NO. 12038-INSTALL SH 2 REV B

© SHOP GRAPHICS • ACCUPRESS REORDER NO. A32861

DWG NO	REV
12765-XX	D

REVISIONS

ECR #	REV	DESCRIPTION	DATE	APPROVED
041	A	RELEASE TO P-LOT	2/24/98	
092	B	REFERENCED NOTES 7 & 8 ADDED NOTE 8	3/7/98	
110	C	MFR P/N FOR SMA CONN CHANGED 2031-5011-00 WAS 2031-5056-00 2037-5007-00 WAS 2037-5056-00	9/16/98	
1406	D	ADDED 12765-05	9/30/98	

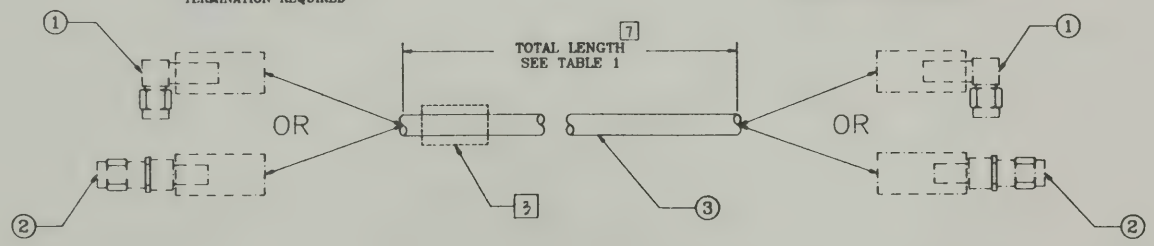


TABLE 1

REV	TNL P/N	END A	END B	LENGTH
D	12765-00	TERMINATE WITH ITEM 1, RIGHT ANGLE SMA PLUG	TERMINATE WITH ITEM 1, RIGHT ANGLE SMA PLUG	6m (20 FT)
D	12765-01	TERMINATE WITH ITEM 1, RIGHT ANGLE SMA PLUG	TERMINATE WITH ITEM 1, RIGHT ANGLE SMA PLUG	REF. ORDER FORM 8
D	12765-02	TERMINATE WITH ITEM 2, STRAIGHT ANGLE SMA PLUG	INTERMATE, ENCLOSE 1 INCH OF ITEM 3 SMA CABLE	150mm (6INCH)
D	12765-03	TERMINATE WITH ITEM 1, RIGHT ANGLE SMA PLUG	INTERMATE, ENCLOSE 1 INCH OF ITEM 3 SMA CABLE	150mm (6INCH)
D	12765-04	TERMINATE WITH ITEM 2, STRAIGHT ANGLE SMA PLUG	INTERMATE, ENCLOSE 1 INCH OF ITEM 3 SMA CABLE	10m (40.3 ft)
D	12765-05	TERMINATE WITH ITEM 2 STRAIGHT SMA PLUG	TERMINATE WITH ITEM 2 STRAIGHT SMA PLUG	5m

NOTES:

1. UNTERMINATED CONNECTORS TO REMAIN IN ORIGINAL MANUFACTURERS PACKAGE AND BE PACKAGED WITH CORRESPONDING CABLE.
2. HAND SOLDERING RMA CORE SOLDER (MILDLY ACTIVATED ROSIN KESTER 282 OR 232) BE USED WHEN HAND SOLDERING. THE FLUX RESIDUE MUST NOT BE REMOVED.
3. APPLY TRIMBLE NAVIGATION PART NO. AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE 0.12 IN MINIMUM AND 0.30 IN AND MAXIMUM HEIGHT IN A PERMANENT CONTRAST COLOR APPLIED DIRECTLY TO THE PART OR WITH A LABEL. LOCATE LABEL 3 TO 6 INCHES FROM TERMINATED END.
4. ELECTRICALLY TEST CABLE ASSY FOR SHORTS AND CONTINUITY 100%.
5. AFTER ASSY, THE FOLLOWING TEST WILL BE PERFORMED ON EACH CABLE TERMINATION. (100% TESTING NOT AN AQL SAMPLING UNLESS OTHERWISE NOTED)
   1. PULL TEST, THE CABLE TERMINATION WILL WITHSTAND A PULL OF 18 LBS.
   2. CONTINUITY TEST, THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE ABOVE TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.
6. CERTIFICATION OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.
7. TOLERANCE ON LENGTH IS ±2.0% OF TOTAL LENGTH. LENGTH IS MEASURED FROM END TO END, INCLUDING CONNECTORS.
8. WHEN ORDERING PART NO. 12765-01 (SPECIALTY LENGTH) TNL MUST SPECIFY SALES ORDER NUMBER VENDOR MUST INCLUDE THIS NUMBER ON PACKING LIST.

ITEM	QTY	REV	PROD NO	PART OR IDENTIFYING NO.	DESCRIPTION	VENDOR SPECIFICATION
3	A/R				CABLE, COAX, RG-142 TYPE	BELDEN 9850
2	A/R				CONN SMA STRAIGHT PLUG CRIMP STYLE	ORDER SPECTRA 2031-5011-00
1	A/R				CONN SMA RIGHT ANGLE PLUG CRIMP STYLE	ORDER SPECTRA 2037-5007-00

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ±; DECIMALS ±; ANGLES ±; XX ±; XXX ±

MATERIAL: SEE PARTS LIST

FINISH: ---

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO

APPROVALS	DATE
DRAWN DLB7	7/30/98
CHECKED	
ISSUED	

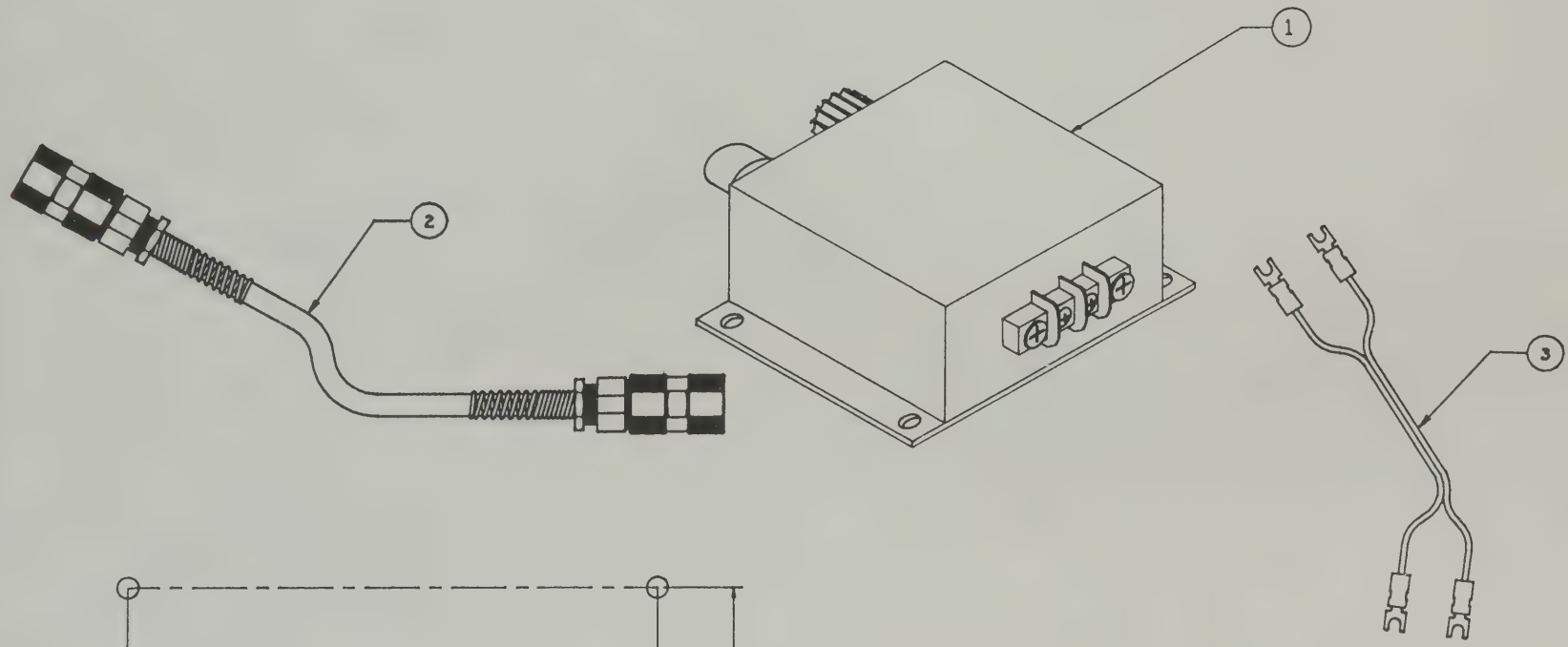
TRIMBLE NAVIGATION

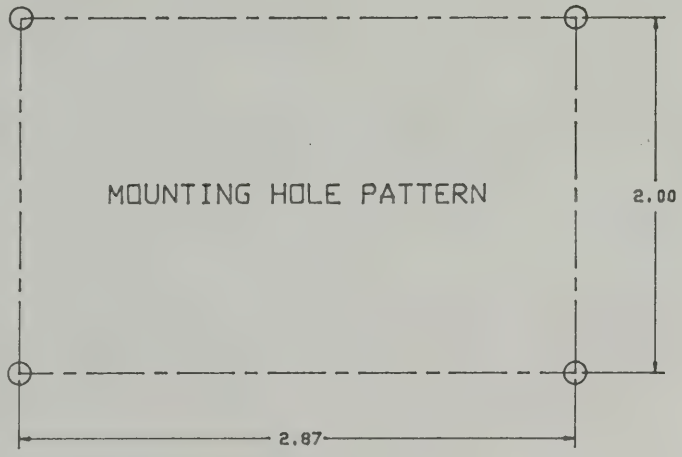
CBL ASSY, SBNS TO ANT

SIZE D | FSCM NO. | DWG NO 12765 | REV D

SCALE | SHEET 1 OF 1

REVISIONS				
	0	AS DRAWN		
1465	A	RELEASED TO DOC CONTROL		





NOTES:

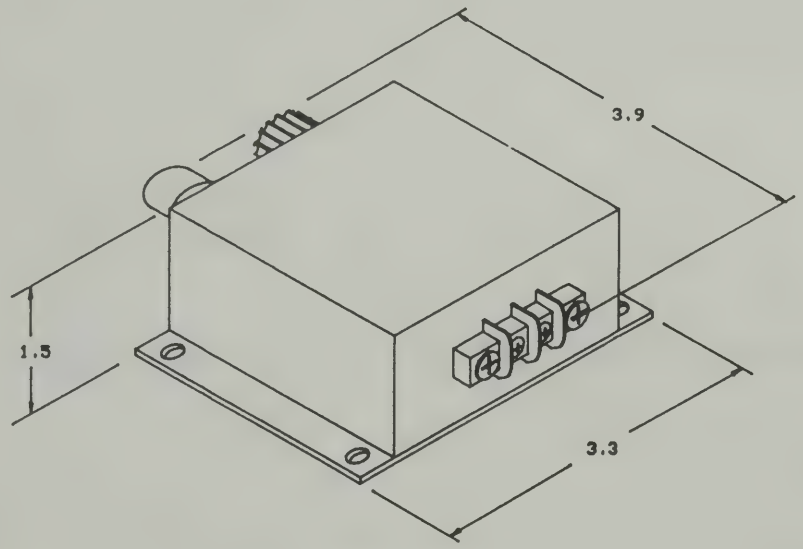
1 USE # 6 HARDWARES TO MOUNT UNIT.

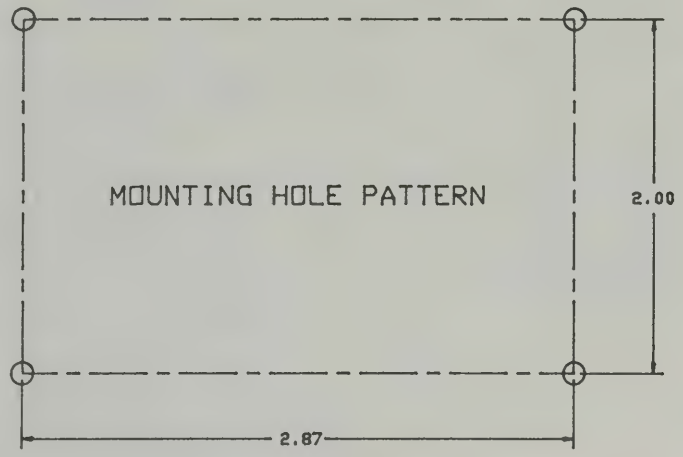
3	1	CBL ASSY, VPA/PVR	13849-00
2	1	CBL ASSY, TRIMPACK/VPA	13830-00
1	1	ASSY, VEHICLE POWER ADAPTER	13815-00
ITEM	QTY	DESCRIPTION	PART NUMBER

PARTS LIST

APPROVALS	DATE	TRIMBLE NAVIGATION	
KVDK LU1	12/7/98	OPTION, VEHICLE POWER ADAPTER TRIMPACK	
		SIZE FSCM DWG. NO. 13825-00	REV. A
APPLICATION	DO NOT SCALE DRAWING	SCALE NONE	SHEET 1 OF 1

REVISIONS				
	DIN		DATE	APPROVED
	0	AS DRAWN	12/7/98	
	A	RELEASED TO DOC CONTROL		



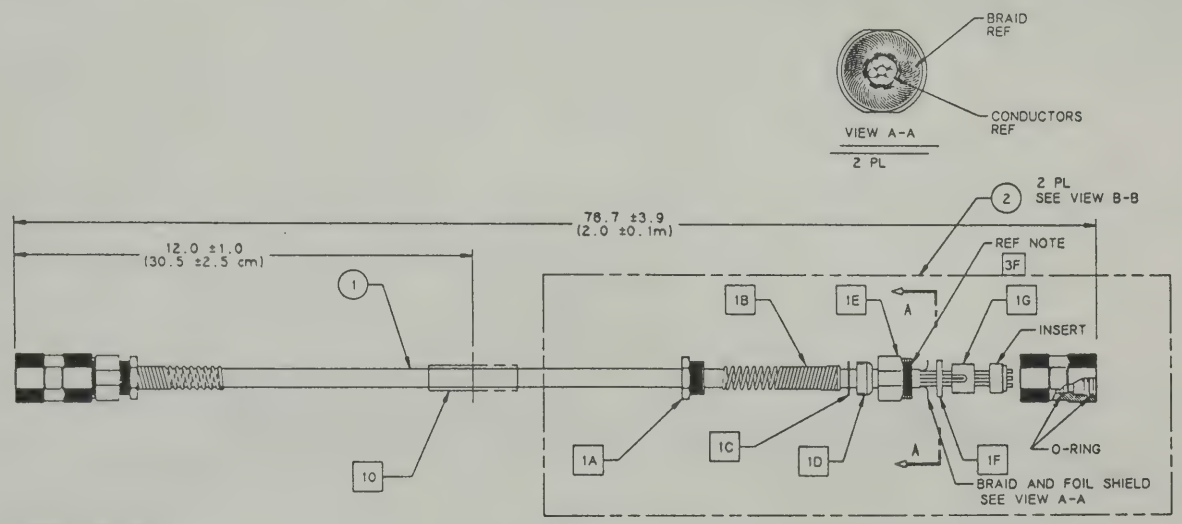


NOTES:

1 USE # 6 HARDWARES TO MOUNT UNIT.

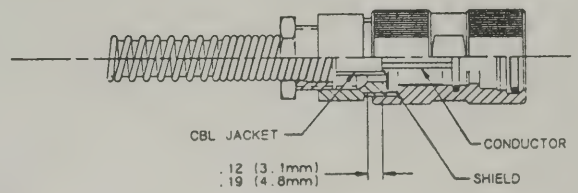
			PARTS LIST		
				TRIMBLE NAVIGATION	
			KVOK LUI 12/7/98	VEHICLE POWER ADAPTER TRIMPACK	
				SIZE B DWG NO 13815-00	REV. A
NEXT ASSY	USED ON				
APPLICATION		DO NOT SCALE DRAWING		SCALE NONE	SHEET 2 OF 2

REVISIONS				
ECN	LTR	DESCRIPTION	DATE	APPROVED
	0	AS DRAWN		
1172	A	ADDED TNL #13874 REL TO DOC CONTROL	2/7/89	J Lovelace



WIRING SCHEMATIC

AUDIO CONN PIN/SIGNAL		CONDUCTOR WIRE COLOR	AUDIO CONN SIGNAL/PIN	
		ORANGE	NOT USED	
B	Ext Gnd	BLACK	Ext Gnd	B
		GREEN	NOT USED	
D	Ext Vin	RED	Ext Vin	D
		WHITE	NOT USED	
		BLUE	NOT USED	



VIEW B-B

NOTES: UNLESS OTHERWISE SPECIFIED

[1] IF YOU ARE ASSEMBLING A CABLE ON THE INSERT, FIRST LOAD THE PIECE PART ON THE CABLE IN THE FOLLOWING ORDER.

A. STUD
B. STRAIN RELIEF SPRING
C. FLAT WASHER METAL
D. BUSHING (FLATER END FIRST)
E. ADAPTER NUT, REFER NOTE [3F]
F. RUBBER WASHER
G. LOADING SLEEVE

2. AUDIO CONN TERMINATION INSTRUCTION:

A. STRIP CABLE JACKET BACK 0.50" ±.02" TO EXPOSED BRAID AND FOIL SHIELD.
B. FAN OUT SHIELDS.
C. WIRE PER WIRING SCHEMATICS.

[3] ASSY OF 2-229/U CONNECTOR.

A. FIND "O" RINGS AND LARGE SHELL BODY.
B. INSERT "O" RINGS IN SHELL. THE SMALLER "O" RING GOES IN THE GROOVE NEAR THE CENTER OF THE SHELL, AND THE LARGER "O" RING GOES IN THE GROOVE NEAR THE END OF THE SHELL. REFER TO SECTION VIEW OF ASSEMBLED CONN ON SALES DRAWING.
C. NEXT INSERT THE INSERT. LINE UP THE TWO KEYS ON THE INSERT WITH THE TWO KEYWAYS IN THE SHELL. IT WILL BE A TIGHT FIT.
D. THE LOADING SLEEVE GOES IN NEXT.
E. INSERT RUBBER WASHER NEXT
F. USING A 220 SANDPAPER ABRADE AWAY THE ANODIZED LAYER ON THE FLAT SURFACE (FACING RUBBER WASHER 1F) OF THE ADAPTER NUT.
G. TIGHTEN ALL THOSE PARTS DOWN WITH THE ADAPTER NUT. IT WILL SCREW INTO THE BACK END OF THE SHELL. BE SURE BRAID AND FOIL DO NOT INTERFERE WITH THE THREADING BETWEEN ADAPTER NUT AND SHELL.

H. THE BLACK RUBBER GROMMET OR BUSHING GOES ON NEXT. THE END WITH THE LARGE CHAMFER GOES IN FIRST. (BE SURE THE JACKET OF THE CABLE PROTRUDE BEYOND THE RUBBER GROMMET BY AT LEAST .12"(3.1mm) MIN AND .19"(4.8mm) MAX).
I. THE FLAT METAL WASHER GOES ON NEXT.
J. POSITION THE STRAIN RELIEF SPRING INSIDE THE STUD (THE STUD HAS A HEX SHAPE TO IT)AND SCREW THE STUD INTO THE BACK END OF THE ADAPTER NUT.

4. WHEN HAND SOLDERING USE ONLY RMA CORE SOLDER (MILDLY ACTIVATED ROSIN KESTER 282 OR 2321)THE FLUX RESIDUE MUST NOT BE REMOVED

5. PULL TEST: THE CABLE TERMINATION WILL WITHSTAND A PULL OF 35 ±2 POUNDS.

6. MEASURE THE RESISTANCE BETWEEN THE TWO SHELLS. BE SURE YOU HAVE GOOD CONTACT, IT SHOULD BE LESS THAN 0.5 OHMS.

7. CONTINUITY TEST: THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE ABOVE TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.

8. CERTIFICATE OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.

9. ALL UNUSED CONDUCTORS ARE TRIMMED FLUSH WITH THE CABLE JACKET.

[10] APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE .12 INCHES MINIMUM AND .30 INCHES MAXIMUM HEIGHT, IN A PERMANENT CONTRASTING COLOR, APPLIED DIRECTLY TO THE PART OR WITH A LABEL.

ITEM NO	QTY	MFG PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION/SPECIFICATION	TNL P/N
3				
2	2	U229/UGZ	AUDIO CONN, 5 CONTACT	13233
1	78.7	BELDEN NO. 83606	CBL, 6 COND, 20 AWG	13874

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ±1/64, DECIMALS .XX ±.01, .XXX ±.005, ANGLES ±1°

SEE ABOVE

DWN	M. BASCOS	11/20/88
CHK		
APPVD		
APPVD		
APPVD		

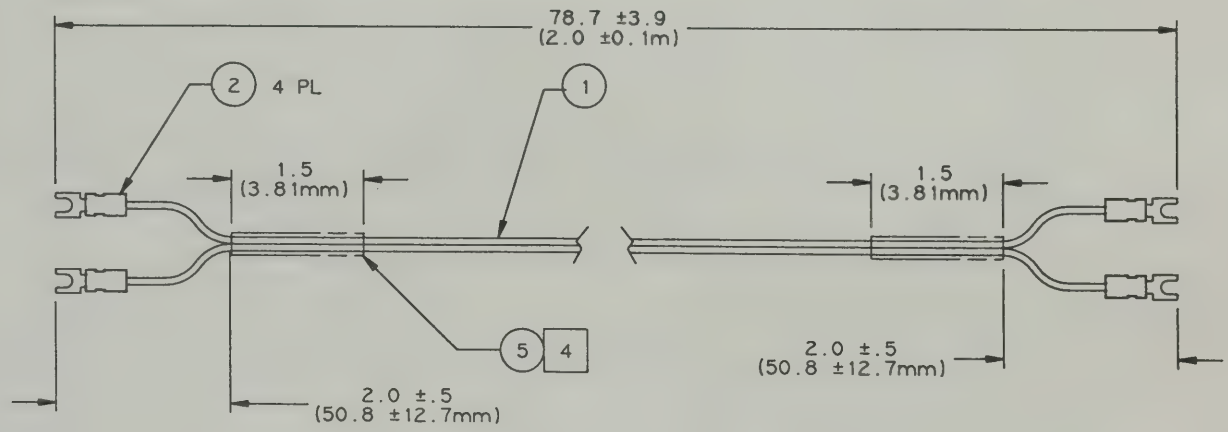
TRIMBLE NAVIGATION

CBL ASSY, TRMPK/VPA

SIZE	CODE IDENT NO	DRAWING NO	REV
D		13830-00	A

SCALE 1/1 SHEET 1 OF 1

REVISIONS				
ECN	LTR	DESCRIPTION	DATE	APPROVED
	0	AS DRAWN		
1172	A	ADDED ITEM 4.5 AND TNL P/N'S, RELEASE TO DOC. CONTROL	2-3-89	JCL
1237	B	18 AWG PARALLEL BONDED WIRE WAS 16 AWG INDIVIDUAL WIRES, ELIMINATED ITEM 4 (TIE WRAPS), ADD '15' LBS. TO PULL TEST.	5/16/89	K R



NOTES:

1. CONTINUITY TEST: THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE PULL TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.
2. PULL TEST: THE CABLE TERMINATION WILL WITHSTAND A PULL OF 15 POUNDS.
3. CERTIFICATE OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.
4. APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETERRING MUST BE .12 INCHES MINIMUM AND .30 INCHES MAXIMUM HEIGHT, IN A PERMANENT, CONTRASTING COLOR, APPLIED DIRECTLY TO THE PART OR WITH A LABEL.

ITEM NO	QTY	MFG PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION/SPECIFICATION	TNL P/N
5	3"	RAYCHEM ATUM 3/16" BLK SUMITOMO ELECTRIC W3B2 3/16" BLK	HEATSHRINK TUBING, 3/16"	13228
4				
3				
2	4	HOFFMAN FVL 2216-S3B	CONN. SPADE LUG. #6 STUD	11598
1	78.7"	BELDEN	WIRE, PARALLEL, RED/BLK, 18 GAGE	12871

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:

FRACTIONAL	DECIMAL	ANGULAR
	.06	

SEE ABOVE

		DATE
DWN	MBJ	12/4/88
CHK		DATE
APPVD		DATE
APPVD		DATE
APPVD		DATE

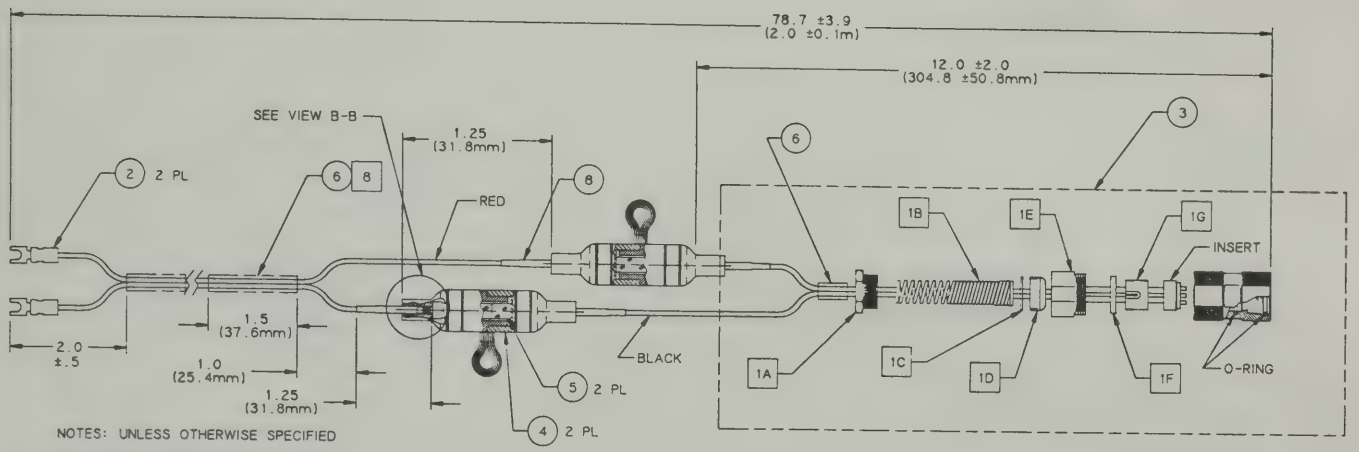
TRIMBLE NAVIGATION

CBL ASSY, VPA/PWR

SIZE	CODE IDENT NO	DRAWING NO	REV
C		13849-00	B

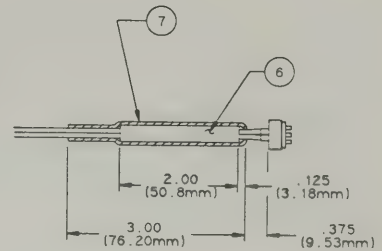
SCALE 1/1 SHEET 1 OF 1

REVISIONS				
ECN	LTR	DESCRIPTION	DATE	APPROVED
	0	AS DRAWN		
1172	A	ADDED TNL . 13228, 11598, 13880, 10284, 13879, 10284 DELETED RTV; ADDED .125 DIM .375 WAS .5; 2.0 WAS 1.0 RELEASED TO DOC CONTROL	2/3/89	J.LOVELL
1237	B	18 AWG PARALLEL BONDED WIRE WAS 16 AWG INDIVIDUAL WIRES(ITEMS 1 & 8) ELIMINATED ITEM 9(TIE WRAPS) ADDED ITEM 8. BUSSMAN HFB WAS HFA	5/6/99	



WIRING SCHEMATIC

AUDIO CONN PIN/SIGNAL		CONDUCTOR WIRE COLOR	AUDIO CONN SIGNAL/PIN	
		ORANGE	NOT USED	
B	Ext Gnd	BLACK	Ext Gnd	B
		GREEN	NOT USED	
D	Ext Vin	RED	Ext Vin	D
		WHITE	NOT USED	
		BLUE	NOT USED	



VIEW A-A

NOTES: UNLESS OTHERWISE SPECIFIED

[1] IF YOU ARE ASSEMBLING A CABLE ON THE INSERT, FIRST LOAD THE PIECE PART ON THE CABLE IN THE FOLLOWING ORDER
- A. STUD
- B. STRAIN RELIEF SPRING
- C. FLAT WASHER METAL
- D. BUSHING (FLATER END FIRST)
- E. ADAPTER NUT
- F. RUBBER WASHER
- G. LOADING SLEEVE

2. ASSY OF 2-229/U CONNECTOR.
- A. FIND "O" RINGS AND LARGE SHELL BODY.
- B. INSERT "O" RINGS IN SHELL. THE SMALLER "O" RING GOES IN THE GROOVE NEAR THE CENTER OF THE SHELL, AND THE LARGER "O" RING GOES IN THE GROOVE NEAR THE END OF THE SHELL. REFER TO SECTION VIEW OF ASSEMBLED CONN ON SALES DRAWING.
- C. NEXT INSERT THE INSERT. LINE UP THE TWO KEYS ON THE INSERT WITH THE TWO KEYWAYS IN THE SHELL. IT WILL BE A TIGHT FIT.
- D. THE LOADING SLEEVE GOES IN NEXT.
- E. INSERT RUBBER WASHER NEXT.
- F. TIGHTEN ALL THOSE PARTS DOWN WITH THE ADAPTER NUT. IT WILL SCREW INTO THE BACK END OF THE SHELL.
- G. THE BLACK RUBBER GROMMET, OR BUSHING GOES ON NEXT. THE END WITH THE LARGE CHAMFER GOES IN FIRST.
- H. THE FLAT METAL WASHER GOES ON NEXT.
- I. POSITION THE STRAIN RELIEF SPRING INSIDE THE STUD (THE STUD HAS A HEX SHAPE TO IT)AND SCREW THE STUD INTO THE BACK END OF THE ADAPTER NUT.

3. WHEN HAND SOLDERING USE ONLY RMA CORE SOLDER (MILDLY ACTIVATED ROSIN KESTER 282 OR 232)THE FLUX RESIDUE MUST NOT BE REMOVED.

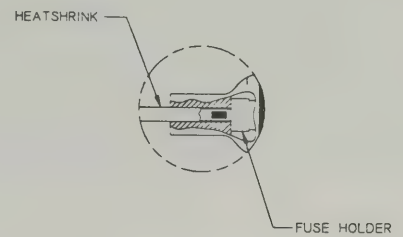
4. PULL TEST: THE CABLE TERMINATION WILL WITHSTAND A PULL OF 35 ±2 POUNDS.

5. CONTINUITY TEST: THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE ABOVE TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.

6. CERTIFICATE OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.

[7] INSTALL ITEM 6,7 USING VIEW A-A AS REF.

[8] APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE .12 INCHES MINIMUM AND .30 INCHES MAXIMUM HEIGHT, IN A PERMANENT CONTRASTING COLOR, APPLIED DIRECTLY TO THE PART OR WITH A LABEL.



VIEW B-B
4 PL

ITEM NO	QTY	MFG PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION/SPECIFICATION	TNL P/N
8	5"	RAYCHEM ATUM 1/8" BLK SUMITOMO ELECTRIC FSB-1/8 BLK	TUBING, HEATSHRINK, 1/8 ENV SEAL	13237
7	3	RAYCHEM ATUM 3/8" BLK SUMITOMO ELECTRIC FSB-3/8 BLK	TUBING, HEATSHRINK, 3/8 ENV SEAL	13227
6	.9"	RAYCHEM ATUM 3/16" BLK SUMITOMO ELECTRIC FSB 3/16 BLK	TUBING, HEATSHRINK, 3/16 ENV SEAL	13228
5	2	LITTLEFUSE 31201.5	FUSE, 1.5A, 3AG, SLO BLO	11119
4	2	BUSSMAN HFB	FUSEHOLDER, WATERPROOF	14241
3	1	U229/UG2	AUDIO CONN, 5 CONTACT	13233
2	2	HOFFMAN-FVL22'6-S-3B	CONN, SPADE LUG, #6 STUD	11598
1	78.7"		WIRE PARALLEL, RED/BLK 18 GAGE	1287

PARTS LIST

TRIMBLE NAVIGATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:			
FR	FR	MILLS	
± .06	± .	± .	

SEE ABOVE

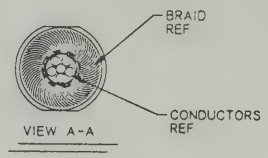
DWN	M. BASCOS	DATE 11/20/88
CHK		DATE
APPVD		DATE
APPVD		DATE
APPVD		DATE

CBL ASSY, TRMPK/ PWR FUSE NSHLD

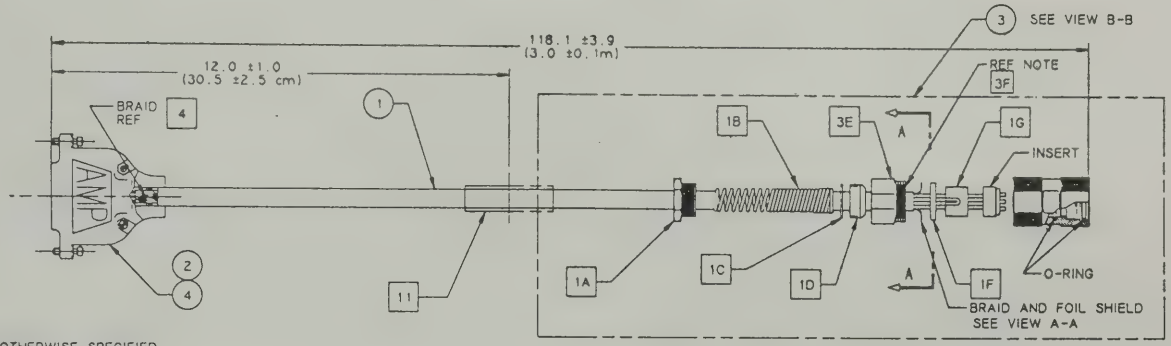
SIZE D1 | CODE IDENT NO | DRAWING NO 12792-00 | REV B

SCALE 1/1 | SHEET 1 OF 1

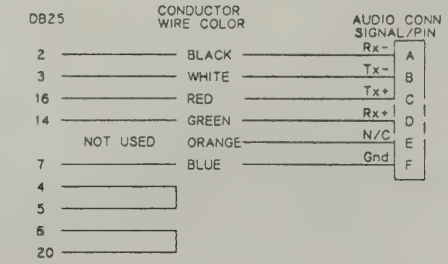
REVISIONS				
ECN	LTR	DESCRIPTION	DATE	APPROVED
	0	AS DRAWN		
1172	A	ADDED TNL #13874 REL TO DOC CONTROL	2/3/94	J LOVE



VIEW A-A



WIRING SCHEMATIC



NOTES: UNLESS OTHERWISE SPECIFIED

[1] IF YOU ARE ASSEMBLING A CABLE ON THE INSERT, FIRST LOAD THE PIECE PART ON THE CABLE IN THE FOLLOWING ORDER.

A. STUD
B. STRAIN RELIEF SPRING
C. FLAT WASHER METAL
D. BUSHING (FLATER END FIRST)
E. ADAPTER NUT, REF NOTE [3F]
F. RUBBER WASHER
G. LOADING SLEEVE

2. AUDIO CONN TERMINATION INSTRUCTION:

A. STRIP CABLE JACKET BACK 0.50" ±.02" TO EXPOSED BRAID AND FOIL SHIELD.
B. FAN OUT SHIELDS.
C. WIRE PER WIRING SCHEMATICS.

[3] ASSY OF GC 329/G2 CONNECTOR.

A. FIND "O" RINGS AND LARGE SHELL BODY.
B. INSERT "O" RINGS IN SHELL. THE SMALLER "O" RING GOES IN THE GROOVE NEAR THE CENTER OF THE SHELL, AND THE LARGER "O" RING GOES IN THE GROOVE NEAR THE END OF THE SHELL. REFER TO SECTION VIEW OF ASSEMBLED CONN ON SALES DRAWING.
C. NEXT INSERT THE INSERT. LINE UP THE TWO KEYS ON THE INSERT WITH THE TWO KEYWAYS IN THE SHELL. IT WILL BE A TIGHT FIT.
D. THE LOADING SLEEVE GOES IN NEXT.
E. INSERT RUBBER WASHER NEXT
F. USING A 220 SANDPAPER ABRADE AWAY THE ANODIZED LAYER ON THE FLAT SURFACE (FACING RUBBER WASHER 1F) OF THE ADAPTER NUT.
G. TIGHTEN ALL THOSE PARTS DOWN WITH THE ADAPTER NUT IT WILL SCREW INTO THE BACK END OF THE SHELL BE SURE BRAID AND FOIL DO NOT INTERFERE WITH THE THREADING BETWEEN ADAPTER NUT AND SHELL

H. THE BLACK RUBBER GROMMET, OR BUSHING GOES ON NEXT. THE END WITH THE LARGE CHAMFER GOES IN FIRST.(BE SURE THE JACKET OF THE CABLE PROTRUDE BEYOND THE RUBBER GROMMET BY AT LEAST .12"(3.1mm) MIN AND .19"(4.8mm) MAX).
I. THE FLAT METAL WASHER GOES ON NEXT.
J. POSITION THE STRAIN RELIEF SPRING INSIDE THE STUD (THE STUD HAS A HEX SHAPE TO IT)AND SCREW THE STUD INTO THE BACK END OF THE ADAPTER NUT.

[4] BE SURE BRAID AND FOIL SHIELDS ARE FOLDED BACK OVER JACKET AND CLAMP DOWN SECURELY BY RIDGES IN THE METAL CONN HOUSING.

5. WHEN HAND SOLDERING USE ONLY RMA CORE SOLDER (MILDLY ACTIVATED ROSIN KESTER 282 OR 232)THE FLUX RESIDUE MUST NOT BE REMOVED

6. PULL TEST: THE CABLE TERMINATION WILL WITHSTAND A PULL OF 35 ±2 POUNDS.

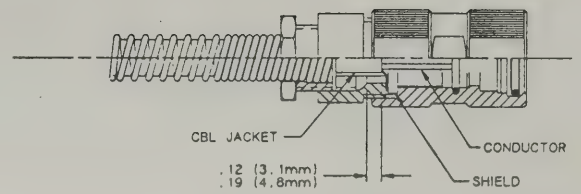
7. MEASURE THE RESISTANCE BETWEEN THE TWO SHELLS. BE SURE YOU HAVE GOOD CONTACT, IT SHOULD BE LESS THAN 0.5 OHMS.

8. CONTINUITY TEST: THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE ABOVE TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.

9. CERTIFICATE OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.

10. ALL UNUSED CONDUCTORS ARE TRIMMED FLUSH WITH THE CABLE JACKET.

[11] APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE .12 INCHES MINIMUM AND .30 INCHES MAXIMUM HEIGHT, IN A PERMANENT CONTRASTING COLOR, APPLIED DIRECTLY TO THE PART OR WITH A LABEL.



VIEW B-B

ITEM NO	QTY	MFG PART NO OR IDENTIFY NO NO	NOMENCLATURE OR DESCRIPTION/SPECIFICATION	TNL P/N
5				
4	1	TYCO CANNON DB25S AMPHENOL DD23	DB25 CONN	11213
3	1	GC 329/G2	AUDIO CONN, 6 CONTACT	13234
2	1	AMP 745173-5	DB25 SHIELDED HOUSING	11568
1	118"	BELDEN NO. 83606	CBL. 6 COND. 20 AWG	13874

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: .XX ±.03 .XXX ±.010 ANGLES ±2°

SEE ABOVE

		DATE
DWN	M. BASCOS	11/20/98
CHK		
APPVD		
APPVD		
APPVD		

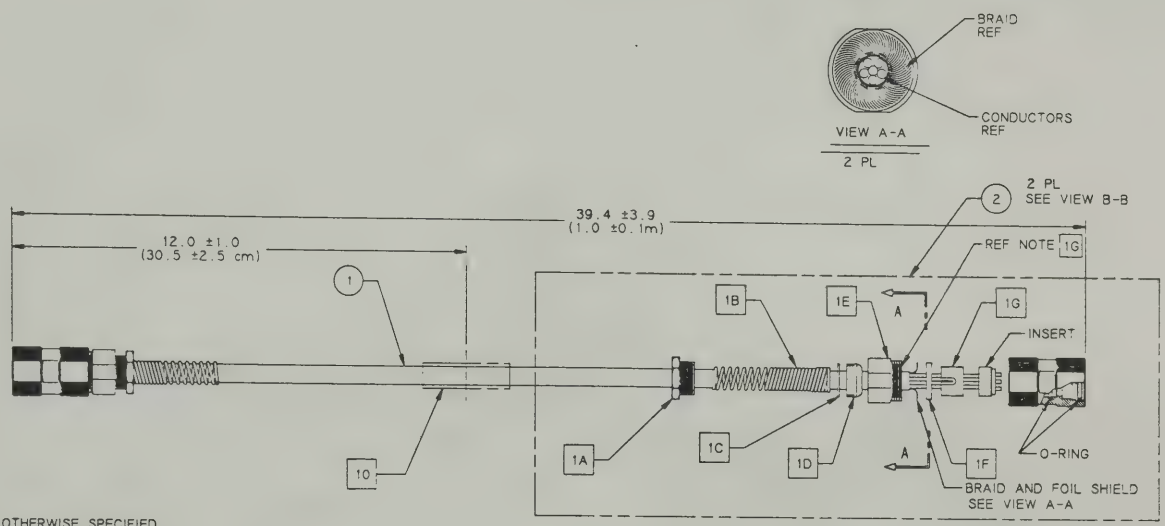
TRIMBLE NAVIGATION

CBL ASSY, TRMPK/EXT I/O

SIZE	CODE IDENT NO	DRAWING NO	REV
D		12793-00	A

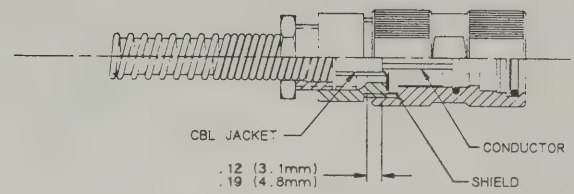
SCALE 1/1 SHEET 1 OF 1

REVISIONS				
ECN	LTR	DESCRIPTION	DATE	APPROVED
	0	AS DRAWN		
1172	A	ADDED TNL #13874 REL TO DOC CONTROL	2/2/94	J Lorbeer



WIRING SCHEMATIC

AUDIO CONN PIN/SIGNAL		CONDUCTOR WIRE COLOR	AUDIO CONN SIGNAL/PIN	
A	Rx-	BLACK	Tx-	B
B	Tx-	WHITE	Rx-	A
C	Tx+	RED	Rx+	D
D	Rx+	GREEN	Tx+	C
E	N/C NOT USED	ORANGE	N/C	E
F	Gnd	BLUE	Gnd	F



VIEW B-B

NOTES: UNLESS OTHERWISE SPECIFIED

[1] IF YOU ARE ASSEMBLING A CABLE ON THE 'NSERT, FIRST LOAD THE PIECE PART ON THE CABLE IN THE FOLLOWING ORDER.
- A. STUD
- B. STRAIN RELIEF SPRING
- C. FLAT WASHER METAL
- D. BUSHING (FLATER END FIRST)
- E. ADAPTER NUT, REF NOTE [3F]
- F. RUBBER WASHER
- G. LOADING SLEEVE

2. AUDIO CONN TERMINATION INSTRUCTION:
- A. STRIP CABLE JACKET BACK 0.50" ±.02" TO EXPOSED BRAID AND FOIL SHIELD.
- B. FAN OUT SHIELDS.
- C. WIRE PER WIRING SCHEMATICS.

[3] ASSY OF GC 329/G2 CONNECTOR.
- A. FIND "O" RINGS AND LARGE SHELL BODY.
- B. INSERT "O" RINGS IN SHELL. THE SMALLER "O" RING GOES IN THE GROOVE NEAR THE CENTER OF THE SHELL, AND THE LARGER "O" RING GOES IN THE GROOVE NEAR THE END OF THE SHELL. REFER TO SECTION VIEW OF ASSEMBLED CONN ON SALES DRAWING.
- C. NEXT INSERT THE INSERT. LINE UP THE TWO KEYS ON THE INSERT WITH THE TWO KEYWAYS IN THE SHELL. IT WILL BE A TIGHT FIT.
- D. THE LOADING SLEEVE GOES IN NEXT.
- E. INSERT RUBBER WASHER NEXT.
- F. USING A 220 SANDPAPER ABRADE AWAY THE ANODIZED LAYER ON THE FLAT SURFACE (FACING RUBBER WASHER 1F) OF THE ADAPTER NUT
- G. TIGHTEN ALL THOSE PARTS DOWN WITH THE ADAPTER NUT. IT WILL SCREW INTO THE BACK END OF THE SHELL. BE SURE BRAID AND FOIL DO NOT INTERFERE WITH THE THREADING BETWEEN ADAPTER NUT AND SHELL.
- H. THE BLACK RUBBER GROMMET, OR BUSHING GOES ON NEXT. THE END WITH THE LARGE CHAMFER GOES IN FIRST. (BE SURE THE JACKET OF THE CABLE PROTRUDE BEYOND THE RUBBER GROMMET BY AT LEAST .12"(3.1mm) MIN AND .19"(4.8mm) MAX).
- I. THE FLAT METAL WASHER GOES ON NEXT.
- J. POSITION THE STRAIN RELIEF SPRING INSIDE THE STUD (THE STUD HAS A HEX SHAPE TO IT)AND SCREW THE STUD INTO THE BACK END OF THE ADAPTER NUT.

4. WHEN HAND SOLDERING USE ONLY RMA CORE SOLDER (MILDLY ACTIVATED ROSIN KESTER 282 OR 232)THE FLUX RESIDUE MUST NOT BE REMOVED

5. PULL TEST: THE CABLE TERMINATION WILL WITHSTAND A PULL OF 35 ±2 POUNDS.

6. MEASURE THE RESISTANCE BETWEEN THE TWO SHELLS. BE SURE YOU HAVE GOOD CONTACT. IT SHOULD BE LESS THAN 0.5 OHMS.

7. CONTINUITY TEST: THE CONTINUITY OF ALL CONNECTIONS WILL BE CHECKED AFTER THE ABOVE TEST HAVE BEEN PERFORMED. THIS WILL INCLUDE A TEST FOR SHORTS AND OPENS.

8. CERTIFICATE OF COMPLIANCE MUST ACCOMPANY EACH SHIPMENT.

9. ALL UNUSED CONDUCTORS ARE TRIMMED FLUSH WITH THE CABLE JACKET.

[10] APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE .12 INCHES MINIMUM AND .30 INCHES MAXIMUM HEIGHT, IN A PERMANENT CONTRASTING COLOR, APPLIED DIRECTLY TO THE PART OR WITH A LABEL.

ITEM NO	QTY	MFG PART NO OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION/SPECIFICATION	TNL P/N
3				
2	2	GC 329/G2	AUDIO CONN. 6 CONTACT	13234
1	39.4"	BELDEN NO. 83606	CBL. 6 COND. 20 AWG	13874

PARTS LIST

TRIMBLE NAVIGATION

DWN	V. BASCOS	11/20/88
CHK		DATE
APPVD		DATE
APPVD		DATE
APPVD		DATE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FR. ± .06, FR. ± ., WELDS ± .

SEE ABOVE

CBL ASSY, TRMPK/TRMPK I/O

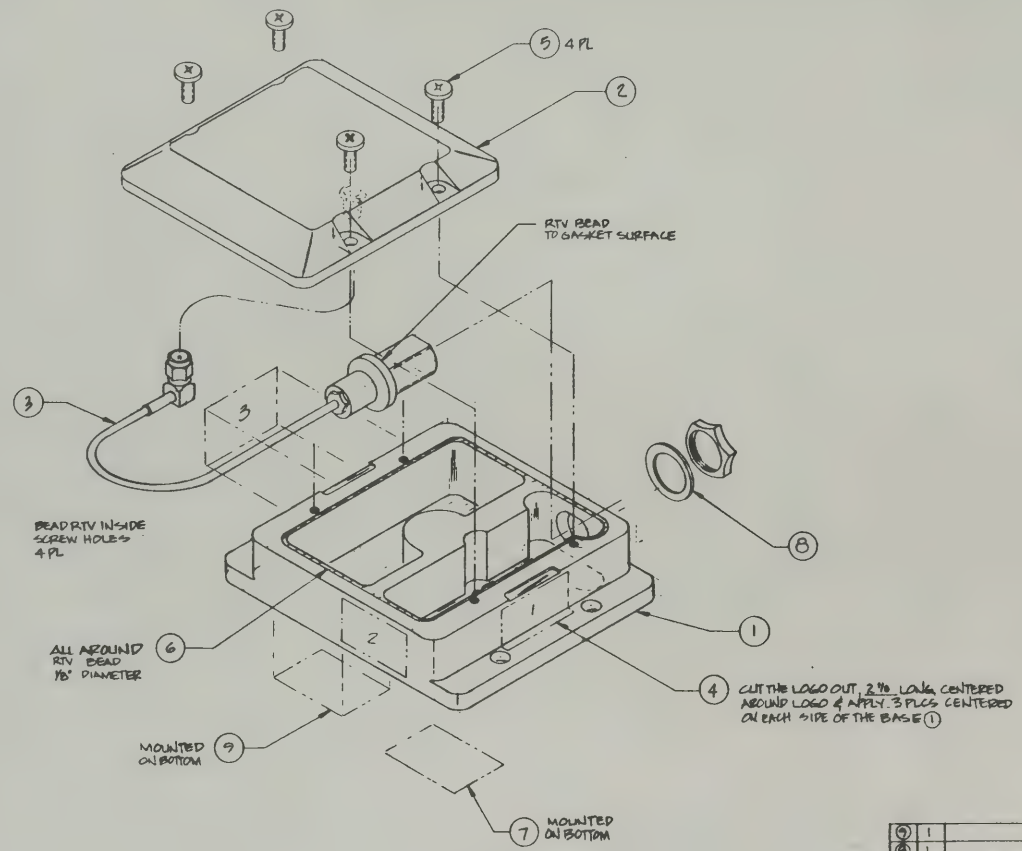
SIZE	CODE IDENT NO	DRAWING NO	REV
D		13826-00	A

SCALE 1/1 SHEET OF

DWG NO	12960-00	REV	C

REVISIONS

ECN	REV	DESCRIPTION	DATE	APPROVED
	A	AS DRAWN	8/09/13	AFL
10655	C	ADDED ITEM (9), ITEM 7 WAS #12114 ADDED 11947 TO THE BOM. REL TO DOC CONTROL	08/10/17	AFL



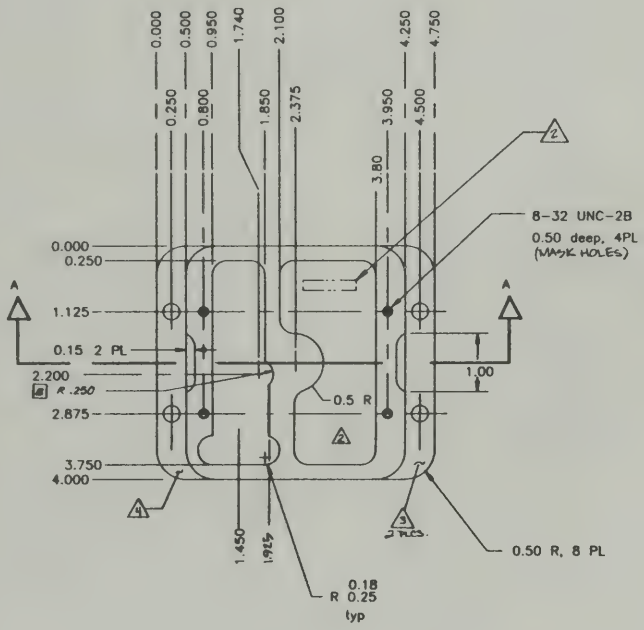
PARTS LIST

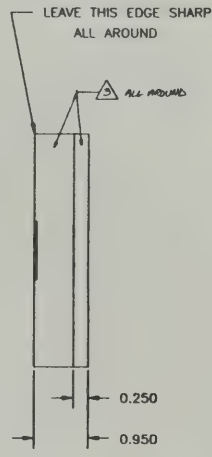
ITEM	QTY PER	MFG PART NO.	DESCRIPTION OR DESCRIPTION	TN PART NO.
9	1		LABEL, CAUTION ANTENNA	11467
8	1		FLAT WASHER, 5/8 ID	12504
7	1		SERIAL NO. LABEL	13199
6	AR	GE128	RTV	10364
5	4		SCREW, PHD, PHIL, 8-32 X 1/2, SS	11059
4	2		LOGO	11947
3	1		CABLE	12809
2	1		ANTENNA	12038-00
1	1		ANTENNA BASE	13033

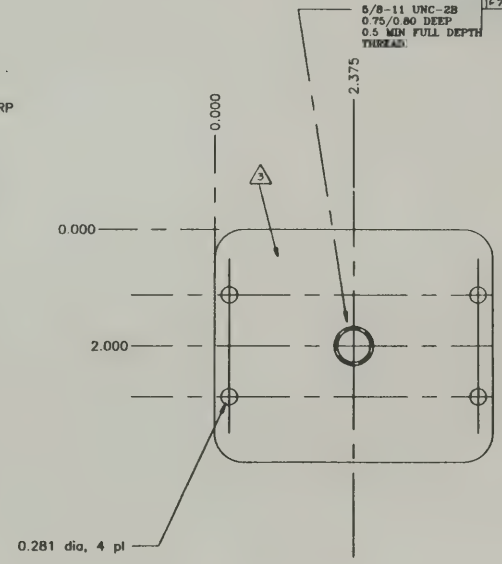
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS .XX ± .XXX ± ANGLES ±	CONTRACT NO PATHFINDER	TRIMBLE NAVIGATION
MATERIAL SEE ABOVE	APPROVALS DRAWN MBJ 8/5/80 CHECKED AFL 8/09/13	ASSY ANT TANS W/ TYPE N-CONN
FINISH	ISSUED	SIZE D FSCM NO DWG NO 12960-00 REV C
NEXT ASSY USED ON		SCALE NTS SHEET 1 OF 1
APPLICATION	DO NOT SCALE DRAWING	

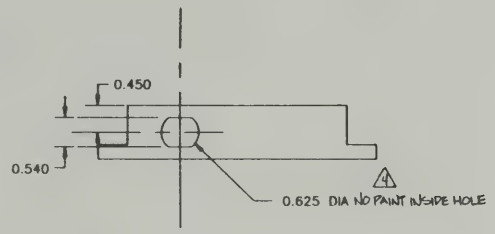
DWG NO	REV
13033	G

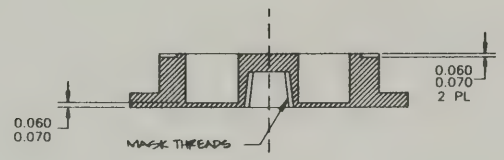
ECN	REV.	DESCRIPTION	DATE	APPROVED
	A	PILOT BUILD	5/11/88	[illegible]
	B	DELETED NOTE 5, ADDED R .250	6/24/88	
1011	C	CHG MATERIAL, ADDED PAINT SPEC RELEASED TO DOC CONTROL	8/4/88	
1044	D	ADD FOR SHEET 2 ONLY NOTE 4 TO NOTE 4.	9 13 88	P. Rinck
1224	F	ADD 4 ALODINE, GOLD, CHANGE NOTE 4 TO NOTE 5.	3-23-89	PRINCK
1231	G	ADD 1.925 DIMENSION	3/30/13	AFL











SECTION A-A

NOTES:
1. REMOVE ALL SHARP EDGES AND BURRS.
2. APPLY TRIMBLE NAVIGATION PART NUMBER AND REV LEVEL WHERE SHOWN. THE LETTERING MUST BE 0.12 INCHES MINIMUM AND 0.30 INCHES MAXIMUM HEIGHT, IN A PERMANENT CONTRASTING COLOR. APPLIED DIRECTLY TO THE PART OR WITH A LABEL.
3. CLASS B FINISH (SEE M-P COSMETIC SPEC) WHERE NOTED, CLASS C FINISH ON REMAINDER.
4. ALODINE GOLD
5. PAINT INSIDE & OUT, FULLER OBRIEN SKY WHITE #PFW310-59. MASKS HOLES NOTED.

PARTS LIST

QTY PER ASSY	ITEM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
XX ± .01 ± 1/4°
XXX ± .005

CONTRACT NO

	APPROVALS	DATE
DRAWN	Kevin Lui	5/11/88
CHECKED		
ENGR		

MATERIAL: ALALY 6061-T6
FINISH: SEE NOTES

NEXT ASSY | USED ON
APPLICATION

DO NOT SCALE DRAWING

TRIMBLE NAVIGATION

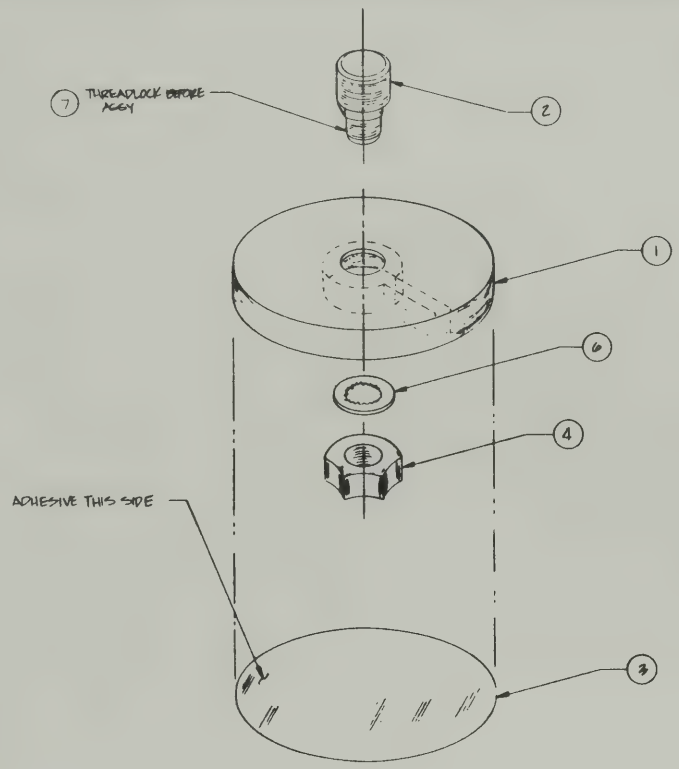
BASE, TANS ANTENNA SURVEY MOUNT

SIZE D | FSCM NO | DWG NO 13033 | REV G
SCALE FULL | SHEET 1 OF 1

DWG NO	SH	REV
12920-00	1	C

REVISIONS

ECN	REV	DESCRIPTION	DATE	APPROVED
	A	AS DRAWN	880607	AFL
1011	B	ADDED ITEM 6 & 7 ON DL RELEASED TO ROC CAMBRIA &	8/11/88	AFL
1065	C	ADDED NOTE 1, ITEM (6) WAS QTY 2	88/10/7	AFL



NOTES:

1 TRIM ITEM (5) TO THE DIA OF ITEM (1) AFTER APPLICATION.

ITEM	QTY REQD	MFG'R	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL
(7)	AR			THREADLOCK	11750
(6)	1			WASHER, INT STAR, 3/8 FINE TOOTH, BRASS OR SS	12236
(5)					
(4)	1			NUT, HEX, 3/8-16, BRASS	12087
(3)	1			COVER	PART OF 12920
(2)	1			THREAD ADAPTER, 5/8-11 TO 3/8-16	13020
(1)	1			MTG BASE W/ MAGNET	12920
				TNL PIN	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS ±, DECIMALS .XX ±, .XXX ±, ANGLES ±	CONTRACT NO: PATHFINDER
MATERIAL: SEE ABOVE	APPROVALS: DRAWN MBJ 8/2/88; CHECKED AFL 9/05/03; ENGR; MFG
FINISH	DATE
NEXT ASSY	USED ON
APPLICATION	DO NOT SCALE DRAWING

TRIMBLE NAVIGATION

ASSY MAGNETIC MNT ADAPTER, MAGNETIC BASE

SIZE D | FSCM NO | DWG NO 12920-00 | REV C

SCALE NTS | SHEET 1 OF 1

APPENDIX C

GLOSSARY

P/N 13498, Rev. D
October 1990

Trimble Navigation Ltd.
Sunnyvale, CA 94086

ABREVIATIONS GLOSSARY

The following abbreviations are used in this manual:

A to D	Analog to digital converter
AH	Ampere hours
ALT	Altitude
ANT	Antenna/preamplifier
AVG	Averaged mode
AZM	Azimuth
C/A	Coarse acquisition code
cc	Cubic centimeters
CONUS	Continental United States
cu. in.	Cubic inches
D to A	Digital to analog
dB	decibels
dBi	Decibels relative to an isotropic radiator
DEC	Decrement
DEG	Degrees
DIST	Distance
DM.	Degree, minutes, decimal minutes coordinate system
DMS	Degree, minutes, seconds coordinate system
Dn	Down
DSP	Digital signal processor
ECEF	Earth centered, earth fixed
ECL	Emmitter coupled logic
EM	Electromagnetic
EXT	External
FIX	Position fix
g's	Acceleration of gravity
GHz	Gigahertz
GMT	Greenwich mean time
GPS	Global positioning system
HDOP	Horizontal dilution of precision
IC	Integrated circuit
IF	Intermediate frequency
INC	Increment
INT	Internal
I/O	Input/output
IREAC	Initialized reaction time
kg	Kilograms
KHz	Kilohertz
Km	Kilometers
KPH	Kilometers per hour
KTS	Knots
L	Left
L1	GPS frequency 1575.42MHz
Lat	Latitude
LCD	Liquid crystal display
LED	Light-emitting diodes
LLA	Latitude, longitude & altitude
LNA	Low noise amplifier
LO	Local oscillator
LOC	Local (time)
Lon	Longitude
m	Meters
MG	Magnetic north reference
MGR or MGRS	Military grid reference system
MHz	Megahertz
MIL	1/6400th of a circle
min	Minute
MPH	Miles per hour
MSL	Mean sea level
m/s/s	Acceleration in meters per second per second
MTBF	Mean time between failures
MTTR	Mean time to repair
NAD	North American Datum
NAV	Navigation
PDOP	Position dilution of precision
POS	Position
PRN	Pseudorandom noise code
R	Right
R+A	Range and azimuth
RADS	Radians
RAM	Random access memory
REAC	Reaction time
RF	Radio frequency
rng	Range
ROM	Read only memory
SEP	Spherical error probability
SIP	Single in-line package

SMA	Sub-miniature Series A
SPCL	Special datums used for MGRS
srg	Slant range
SV	Space vehicle or satellite
STS	Status
TCXO	Temperature compensated crystal oscillator
Tr	True north reference
TTFF	Time to first fix
ttg	Time to go
URA	User range accuracy
UTC	Universal coordinated time (same as GMT)
UTM	Universal Transverse Mercator
VDC	Volts direct current
VDOP	Vertical dilution of precision
vel	Velocity
vrt	Vertical
VSWR	Voltage standing wave ratio
vta	Vertical angle
WGS	World geodetic system
WPT	Waypoint
xte	Cross-track error (L or R)
2-D	Two-dimensional
3-D	Three dimensional
°C	Degrees Celsius (Centigrade)

Days of the week:	SUN	MON	TUE	WED	THU	FRI	SAT

Directions:	N (north)	S (south)	E (east)	W (west)

The following are definitions of the various navigation parameters provided.

Azimuth	The azimuth (bearing) angle from the current position to the selected waypoint along the Great Circle course. Referenced from true or magnetic North, depending on user option selected.
Course	Direction of travel of the TRIMPACK referenced to true or magnetic North. Blinked when the user's velocity is less than 2 m/sec.
Cross-track Error	The distance the current position is right or left of the intended track. The intended track is the Great-Circle course line between two selected waypoints.
Great Circle	The shortest distance between two points on the surface of a sphere.
Range	The 2-dimensional (Great Circle) distance from the current (or last calculated) position to the selected waypoint.
Relative Steering Angle	Specifies the angle to steer to the right or left (and up/down in 3-D homing) to navigate to the waypoint. Angle is referenced to the current course heading (direction of travel) of the user. This data is blinked unless the user has a speed of at least 2 m/sec (horizontal steering angle) or 6 m/sec (vertical steering angle).
Slant Range	The 3-dimensional range (line of sight) from the current position to the selected waypoint.
Time-to-go	The time to go until reaching the selected waypoint based on current position and velocity. To be valid, the user must have a velocity greater than 2 m/sec and be steering toward the waypoint.
Velocity	The velocity of the receiver.
Vertical Difference	The vertical distance between the TRIMPACK position and the selected waypoint.

APPENDIX D

HAVE QUICK/PULSE-PER-SECOND TIMING OUTPUT

P/N 13498, Rev. D
October 1990

Trimble Navigation Ltd.
Sunnyvale, CA 94086

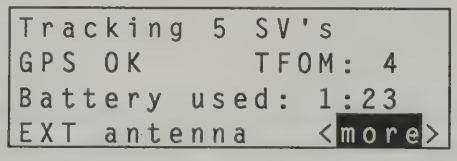
HAVE QUICK/PULSE-PER-SECOND TIMING OUTPUT

The TRIMPACK with the Have-Quick/PPS option will provide 1-Pulse-Per-Second (1PPS) or Have-Quick timing accuracy of 1 μsec when doing position fixes. Have-Quick equipped units are identified by a black rotary knob on the front panel, and the part number is 16768-10. The TOD signal from the TRIMPACK conforms to ICD-GPS-060 (dated 02 June 1986) and is backward compatible with HQI and HQII formats. The signal also includes a Time-Figure-Of-Merit (TFOM) to describe its accuracy consistent with the HQIIA format.

The 1PPS signal also conforms to ICD-GPS-060 except in amplitude (5 volts dc instead of 10). The pulse is 20 μsec long with the leading (positive going) edge indicating the 1 second roll-over of UTC.

The timing output option affects two of the three STS (status) screens. They are described as follows:

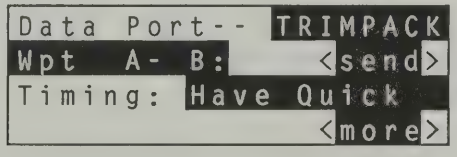
STATUS SCREEN



satellite status
GPS & timing output messages*
battery usage
antenna in use

TFOM/TIMING: In the Have-Quick output mode "TFOM:" will be displayed with a time figure of merit number or n/a (not available) if no solutions have been available. In the PPS mode, during GPS solutions, "TIMING: OK" will be displayed. If no timing is available "TIMING: n/a" is displayed.

DATA PORT CONTROL SCREEN



data port protocol name
send: waypoint/almanac/setup parameters
timing: off/pulse per second/static PPS*
Have-Quick/static HQ

** Have Quick option only*

TIMING OUTPUTS

In the timing option, line 3 provides a selection of the following timing outputs.

Off:	No timing output.
Have-Quick	Have-Quick timing based on GPS 3 or 4 satellite solutions. (If in 3 satellite 2D mode, the altitude must be accurate.)
Static HQ:	Have-Quick timing based on 1 satellite and an accurate known position from current GPS calculation or user input.
PulsPerSec:	Pulse per second timing based on GPS 3 or 4 satellite solutions. (If in 3 satellite 2D mode, the altitude must be accurate.)
Static PPS:	Pulse per second timing based on 1 satellite and an accurate known position from current GPS calculation or user input.

Static Timing Mode

Accurate Have-Quick and 1PPS timing can be achieved with only 1 satellite while using the static options if the user is not moving and knows his precise location. To initialize the TRIMPACK's position, the "copy waypoint to fix" function is used (the waypoint being your location). Timing accuracy in this mode depends on the accuracy of initialized position. Timing errors are 1 μsec per 1000 ft of position error.

When the unit is operating in static timing mode, STATIC is displayed on the main STATUS screen, as well as on the POS and FIX screens; also, the letters STA alternate with the R&A and TO: labels in the top-left corner of the R&A and NAV screens, respectively. Altitude cannot be entered manually in the static timing mode.

NOTE: The TRIMPACK will not assume a position and the time measurement will not be valid until:

- the unit has performed a position fix in normal mode and then is switched to static mode; OR
- the user has used the COPY function to store an accurate waypoint into the FIX.

A TFOM of 7 is usually the maximum TFOM that is used by Have-Quick radios. Actual time degradation will vary, worst case performance is shown. All timing accuracy is lost if the TRIMPACK is turned off.

Timing signals are output on pin E of the TRIMPACK data port. Signal ground is on pin F. Have-Quick and 1 PPS cannot be provided simultaneously because both use the same pin. Static options are for stationary users only. The TRIMPACK side of a Have-Quick TOD cable uses a MC329G2 6 pin audio connector, the Have-Quick radio side depends on the manufacturer. Below is an example for a PRC-113 Have-Quick radio.

TRIMPACK P2 (MC329G2)			PRC-113 P1 (MS27467T15B35S)
E	TOD OUT	———————	TOD IN 10
F	GROUND	———————	GROUND 11

If the TRIMPACK is left on and is no longer doing position fixes the timing accuracy degrades at a maximum rate of 1 μsec per second. The table below describes the TFOM.

Accuracy (μsec)	TFOM	Time HH:MM:SS
1-10	5	00:00:10
10-100	6	00:01:40
100-1000	7	00:16:40
1000-10000	8	02:46:40

APPENDIX E

1089 WAYPOINTS OPTION

P/N 13498, Rev. D
October 1990

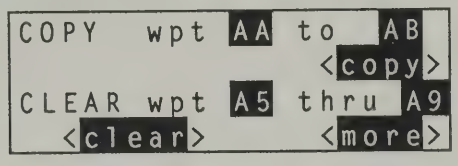
Trimble Navigation Ltd.
Sunnyvale, CA 94086

1089 WAYPOINTS OPTION

This appendix describes the additional capabilities and features of the TRIMPACK unit when equipped with the 1089 Waypoints option.

WAYPOINTS AND THEIR DESIGNATORS

The 1089 waypoint option increases the storage capacity of the TRIMPACK from 26 to 1089 waypoints. All waypoints on all screens are identified by a two-character designator (AA, AB, etc.), rather than the one-character designator shown throughout this manual. All alphabet and numeric characters are used except for I,O and 0 (zero). The following screen illustrates the two-character waypoint system.



source and destination
copy waypoint trigger
waypoints to clear
clear waypoint trigger

NOTE: When copying waypoints from a 1089 waypoint version TRIMPACK to a 26 waypoint TRIMPACK, only the first 26 waypoints in the designated range will be filled and saved.

TRIMBLE NAVIGATION

DOCUMENT IMPROVEMENT FORM

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Paragraph number:

Describe problem or reason for recommended change:

Recommended change:

Remarks

Signature	Telephone No.:
	Date:

C Bre

418 304

up over high ground

Hilltop
Between
Bench Mark to South West

South of .

8E11